INSTRUCTIONS

PG ENGINE CONTROL GOVERNOR

FOR GE 7FDL DIESEL ENGINES

E-11788A

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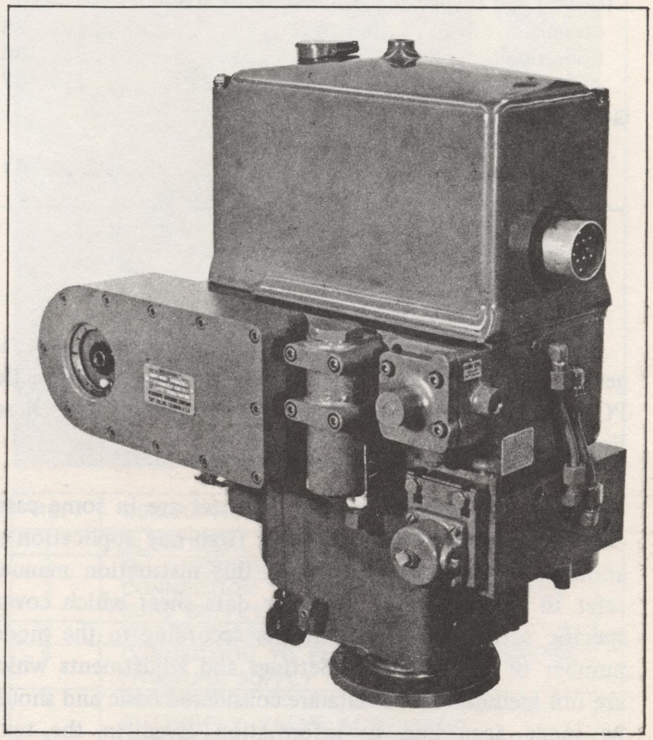

TYPICAL PG ENGINE CONTROL GOVERNOR

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These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

Verify numbers for parts, tools, or material by using the Renewal Parts or Tool Catalogs, or contact your General Electric representative for assistance. Do not order from this publication.

GENERAL ELECTRIC

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FOREWORD

This instruction manual has been prepared to cover, in general, the operation, adjustment and maintenance of the PG style Woodward governor used on GE 7FDL Diesel Engines.

Values and settings used in the text are in some cases only representative and will differ from one application to another. Therefore, when using this instruction manual, refer to the individual governor data sheet which covers specific settings and adjustments according to the model number of the governor. Settings and adjustments which are not included in the data are considered basic and should be made according to information given in the text. Portions of the information contained in this publication have been reproduced through the courtesy of the Woodward Governor Company, Rockford, Illinois.

GENERAL DESCRIPTION

The engine control governor is an electrohydraulic device used to regulate speed and horsepower output on the diesel engine. It also includes a number of auxiliary devices to protect and provide the power plant with characteristics desirable for railway locomotive service.

The governor is a self-contained unit which is mounted on and driven by the diesel engine. It is equipped with its own oil supply and oil pressure pump and is remotely controlled by the locomotive throttle.

During operation the governor performs two basic functions. Primarily, it controls the speed of the diesel engine by regulating the amount of fuel supplied to the engine cylinders. At any speed setting of the governor, speed control is isochronous; that is, the governor maintains constant engine speed regardless of changing conditions of load. The secondary function of the governor is to maintain a constant predetermined horsepower output of the engine for each specific speed setting by accurately controlling the engine load. Control of the engine load is accomplished by adjusting the strength of the generator field to compensate for electrical load changes on the generator and those resulting from variable auxiliary loads such as the air compressor, battery charging generator, etc. Thus, while the primary function of the governor is to maintain speed of the engine, by controlling both speed and load, a condition of balance can be established which results in a constant, single horsepower output for each speed setting of the engine.

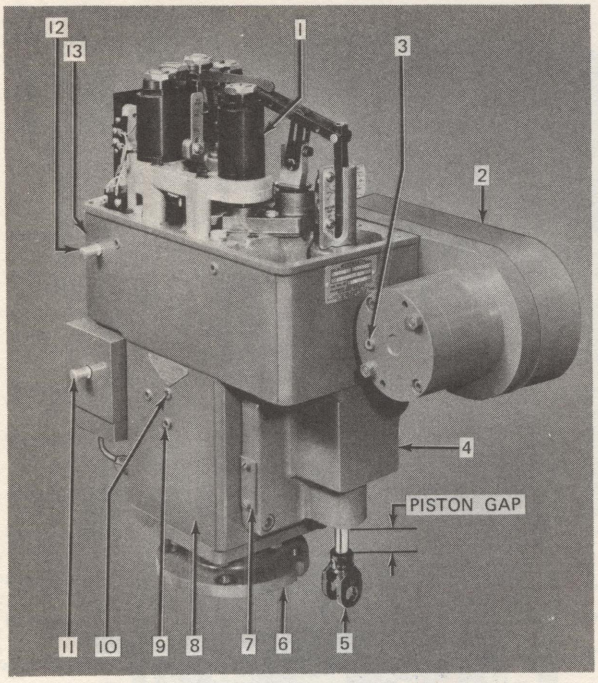
AUXILIARY FUNCTIONS

The governor also has the following auxiliary functions:

1. Remote electrical throttle control for eight notch speeds plus a SHUTDOWN position.
2. Overriding of the normal load control operation to aid in controlling wheelslip and, in some applications, dynamic braking functions.
3. Automatic shutdown of the diesel engine in the event of failure of the lubricating oil pressure or failure of the cooling water pressure. Two switches in the governor provide lights and/or bell warnings in the operator's cab when either of the devices is tripped. At idle speed a time delay is provided on the safety shutdown devices to permit starting the engine while still providing shutdown protection if the pressures fail to develop within the allotted time.
4. An overspeed fuel shut-off valve to automatically shut off fuel to the engine in case of an engine overspeed.

FIG. 1, E-13399

FIG. 2, E-13400



REF.	DESCRIPTION
1	ELECTRIC SOLENOID PACK
2	LOAD CONTROL AND SERVOMOTOR ASSEMBLY
3	VANE SERVOMOTOR PRESSURE TEST OPENING
4	POWER CYLINDER
5	POWER PISTON ROD
6	GOVERNOR BASE
7	COMPENSATING NEEDLE VALVE (UNDER COVER)
8	POWER CASE
9	ACCUMULATOR PRESSURE TEST OPENING
10	AIR VENT OPENING
11	LOW WATER PRESSURE SHUTDOWN RESET BUTTON
12	LOW OIL PRESSURE SHUTDOWN RESET BUTTON
13	COLUMN

FIG. 1. 3/4 VIEW OF A GOVERNOR WITH THE COVER REMOVED.

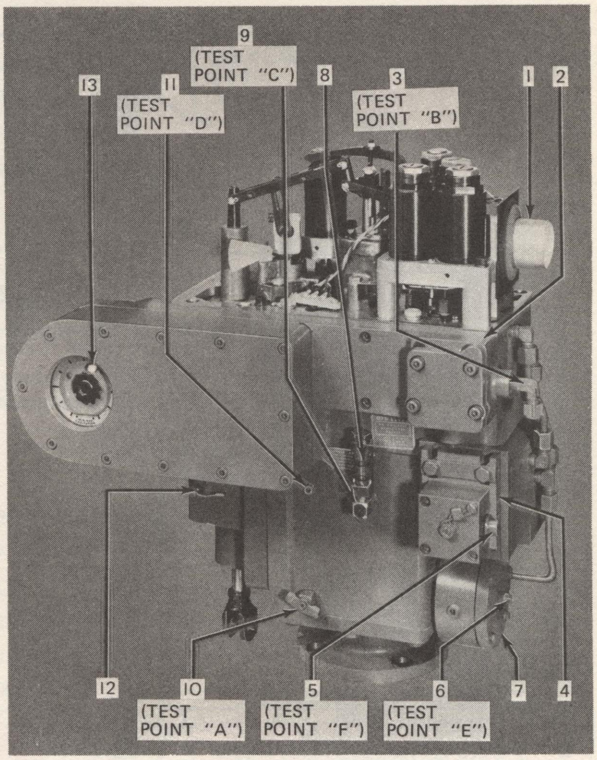
This feature was used prior to 1967 when the overspeed-derater link was added to effect the shutdown function.

5. Limiting of fuel supplied to the engine during starting to provide improved starting characteristics.

BASIC GOVERNOR PARTS (Fig. 1, 2 and 3)

The governor is equipped with the following basic parts:

1. The base which encloses the bottom of the governor and supports the governor drive shaft assembly.
2. The power case containing the oil supply, oil pressure pump and pressure accumulators, as well as the buffer cylinder and main pilot valve assemblies.
3. The column containing the rotating flyweight head, speeder spring, speed setting servo assembly, as well as the speed setting pilot valve and load control pilot valve assemblies. Mounted to the top of the column are the electric speed setting solenoids designated A, B, C and D and the overriding solenoid marked O.



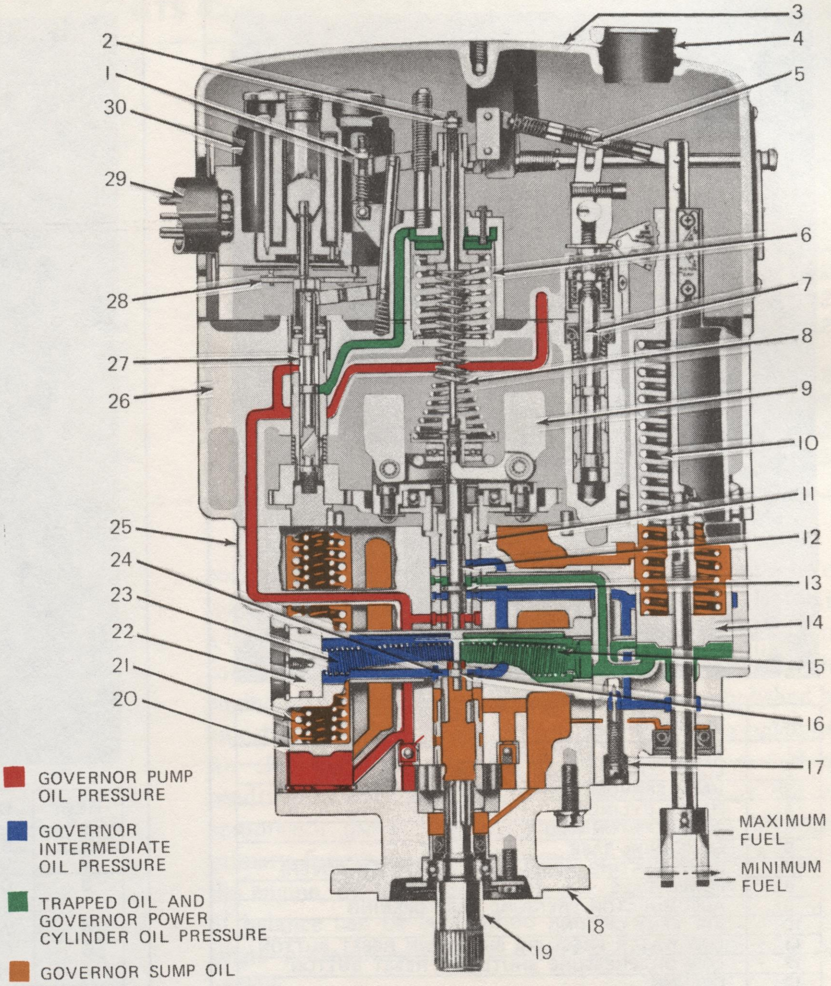
REF.	DESCRIPTION
1	ELECTRICAL CONNECTOR
2	OIL PRESSURE FAILURE DEVICE
3	CONNECTION TO ENGINE LUBE OIL PRESSURE SUPPLY
4	WATER PRESSURE FAILURE DEVICE
5	CONNECTION TO ENGINE COOLING WATER PRESSURE SUPPLY
6	CONNECTION TO OIL RETURN LINE FROM BUTTERFLY VALVE ACTUATORS
7	OVERSPEED FUEL SHUT-OFF VALVE
8	GOVERNOR OIL LEVEL GAGE
9	GOVERNOR OIL PRESSURE
10	GOVERNOR OIL DRAIN
11	"OIL IN" FROM GOVERNOR TEST STAND
12	LOAD CONTROL OIL DRAIN
13	LOAD CONTROL BRUSH ARM INDICATOR

FIG. 2. 3/4 VIEW OF A GOVERNOR WITH THE COVER REMOVED.

Enclosed within the cover at the top of the governor column are levers and linkage which interconnect various other functional parts.

4. The power cylinder assembly which is fastened to the front side of the power case contains the power piston, piston spring and the compensating needle valve. The power cylinder, through its piston and spring, furnishes the controlled mechanical force required to move the control rack on each fuel injection pump.

REF.	DESCRIPTION
1	BASE SPEED SETTING NUT
2	SHUTDOWN ROD AND NUTS
3	COVER
4	OIL FILLER CUP
5	LOAD CONTROL LINKAGE
6	SPEED SETTING CYLINDER AND PISTON
7	LOAD CONTROL PILOT VALVE
8	SPEEDER SPRING
9	FLYWEIGHTS
10	POWER SPRING
11	PILOT VALVE BUSHING
12	PILOT VALVE PLUNGER
13	COMPENSATING LAND ON PILOT VALVE
14	POWER PISTON
15	BUFFER SPRING
16	CONTROL LAND
17	COMPENSATING NEEDLE VALVE
18	BASE
19	DRIVE SHAFT
20	ACCUMULATOR PISTON
21	ACCUMULATOR SPRINGS
22	BUFFER CYLINDER PLUG
23	BUFFER SPRING
24	REGULATING PORT
25	POWER CASE
26	COLUMN
27	SPEED SETTING PILOT VALVE
28	TRIANGULAR PLATE
29	ELECTRICAL CONNECTOR
30	SPEED SETTING SOLENOIDS A-B-C-D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MAXIMUM FUEL
MINIMUM FUEL
18
19
🟥 GOVERNOR PUMP OIL PRESSURE
🟦 GOVERNOR INTERMEDIATE OIL PRESSURE
🟩 TRAPPED OIL AND GOVERNOR POWER CYLINDER OIL PRESSURE
🟧 GOVERNOR SUMP OIL

FIG. 3. BASIC GOVERNOR PARTS.

5. The load control potentiometer and servomotor assembly is attached to the right side of the governor column. It is used to change the value of resistance in the generator excitation circuit. This assembly consists of an electrical resistance unit having a commutator-type selector switch and a pair of contact brushes which are driven by the vane servomotor. Position and movement of the vane servomotor shaft and the contact brushes are controlled by the load control pilot valve, which selects the correct value of resistance required to balance the load at each speed setting of the engine.

DESCRIPTION OF OPERATION

This portion of the manual describes in detail the functions of the various governor systems and auxiliary devices beginning with the basic function – speed control.

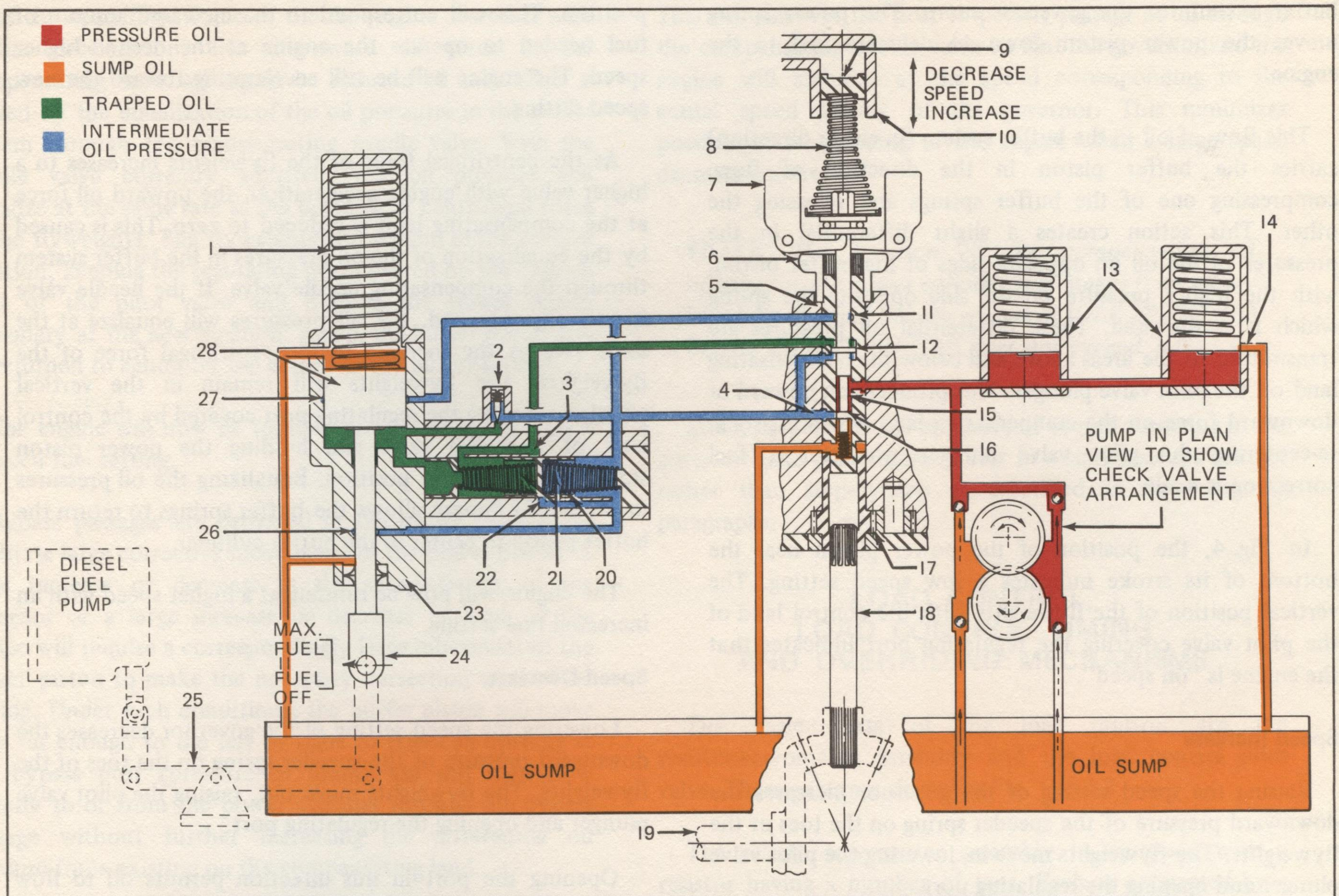
SPEED CONTROL

The schematic diagram in Fig. 4 illustrates the essential parts of the basic PG governor used to regulate fuel and control engine speed.

The governor drive shaft passes through the governor base into the pump drive gear which is directly connected to the rotating pilot valve bushing. The flyweight head is secured to the upper end of the pilot valve bushing, providing a direct drive from the engine to the flyweights. At any speed setting of the governor when the engine is "on-speed", the centrifugal force of the flyweights will balance the opposing force of the speeder spring with the flyweights in the vertical position. The control land of the pilot valve plunger will be covering the regulating ports in the rotating pilot valve bushing.

Pressure seal grooves A, B and C are supplied with pressure oil through the regulating port. This prevents the oil trapped between the power piston and the buffer piston from leaking past the power piston, power piston rod and

FIG. 4, E-11792



REF.	DESCRIPTION
1	POWER SPRING WHICH ACTS TO SHUT OFF FUEL
2	COMPENSATING NEEDLE VALVE
3	BUFFER PISTON BYPASS PORT PILOT VALVE
4	REGULATING PORT
5	ROTATING PILOT VALVE BUSHING
6	FLYWEIGHT HEAD
7	FLYWEIGHT
8	SPEEDER SPRING
9	SPEED SETTING PISTON
10	SPEED SETTING CYLINDER
11	SEAL GROOVE "C"
12	RECEIVING COMPENSATING LAND (INTEGRAL WITH PILOT VALVE PLUNGER)
13	SPRING LOADED ACCUMULATORS
14	OIL BYPASS TO CONTROL MAXIMUM PRESSURE

REF.	DESCRIPTION
15	PILOT VALVE PLUNGER
16	PILOT VALVE CONTROL LAND
17	GEAR OIL PUMP
18	DRIVE SHAFT (MAY ROTATE IN EITHER DIRECTION)
19	DRIVE SHAFT FROM ENGINE
20	BUFFER PISTON
21	BUFFER SPRINGS
22	BUFFER PISTON BYPASS PORT
23	POWER CYLINDER
24	ROD END
25	ENGINE LINKAGE
26	SEAL GROOVE "B"
27	SEAL GROOVE "A"
28	POWER PISTON

FIG. 4. SCHEMATIC DIAGRAM OF BASIC PG GOVERNOR.

pilot valve stem. To make up for leakage of the seal oil and hold the power piston in a steady position against the power spring when the engine is "on-speed" with a steady load, the pilot valve plunger will be enough below center to supply the required amount of oil through the regulating port.

The governor pump supplies pressure oil to the accumulators and rotating pilot valve bushing. Excess oil at maximum pressure passes from the accumulators to the governor oil sump. Some governors have duplicate suction and discharge ball check valves at the governor pump to permit governor rotation in either direction. Governors used on GE locomotives are plugged to allow only one direction of rotation.

Movements of the power piston are transmitted by the piston rod to the fuel injection pumps on the engine. Regulated oil pressure under the power piston is used to raise the power piston to increase fuel. The power spring above the power piston is used to lower the power piston to decrease fuel.

Located between the pilot valve bushing and the power piston is the "buffer" compensating system. It consists of the buffer cylinder and piston, the buffer springs and the compensating needle valve. Lowering the pilot valve plunger permits a flow of pressure oil from the pilot valve bushing into the buffer system and power cylinder. This raises the power piston and increases fuel. Raising the pilot valve plunger results in a flow of oil from the power cylinder and buffer system to the governor sump. The power spring moves the power piston down to decrease fuel to the engine.

This flow of oil in the buffer system (in either direction) carries the buffer piston in the direction of flow, compressing one of the buffer springs and releasing the other. This action creates a slight differential in the pressures of the oil on opposite sides of the buffer piston, with the higher pressure on the side opposite the spring which is compressed. These differential oil pressures are transmitted to the areas above and below the compensating land on the pilot valve plunger. This produces an upward or downward force on the compensating land which assists in re-centering the pilot valve plunger whenever a fuel correction is made.

In Fig. 4, the position of the power piston near the bottom of its stroke indicates a low speed setting. The vertical position of the flyweights with the control land of the pilot valve covering the regulating port indicates that the engine is “on speed”.

Speed Increase

Raising the speed setting of the governor increases the downward pressure of the speeder spring on the toes of the flyweights. The flyweights move in, lowering the pilot valve plunger and opening the regulating port.

Opening the port in this direction admits pressure oil into the buffer system. This causes the buffer piston to move to the left and transfer an equal volume of oil to the power cylinder, forcing the power piston up in the direction to increase fuel.

As the buffer piston moves in the direction of the oil flow, from pilot valve to power cylinder, the left hand buffer spring is compressed and the right hand spring is relieved. This produces an intermediate oil pressure on the right side of the buffer piston which is higher than the pressure of the trapped oil on the left. This pressure is proportional to the buffer piston and spring displacement.

Simultaneously with the movement of the power piston and buffer piston, the differential oil pressures on opposite sides of the buffer piston are transmitted to the upper and lower sides of the compensating land. The higher pressure on the lower side causes an upward force on the compensating land. This force will increase until, added to the upward force of the flyweights, it will balance the speeder spring force. It will also raise the pilot valve plunger enough to cover the regulating port and return the flyweights to the vertical position. As soon as the regulating port is covered, the power piston will be stopped at a new position. This will correspond to the increased amount of fuel needed to operate the engine at the desired higher speed. The engine will be still accelerating toward the new speed setting.

As the centrifugal force of the flyweights increases to a higher value with engine acceleration, the upward oil force at the compensating land is reduced to zero. This is caused by the equalization of the oil pressures in the buffer system through the compensating needle valve. If the needle valve is correctly adjusted, the oil pressures will equalize at the same rate as the increase in the centrifugal force of the flyweights. The flyweights will remain in the vertical position, keeping the regulating port covered by the control land of the pilot valve and holding the power piston stationary at the new position. Equalizing the oil pressures in the buffer system allows the buffer springs to return the buffer piston to center in the buffer cylinder.

The engine will now be running at a higher speed with an increased fuel setting.

Speed Decrease

Lowering the speed setting of the governor decreases the downward pressure of the speeder spring on the toes of the flyweights. The flyweights move out, raising the pilot valve plunger and opening the regulating port.

Opening the port in this direction permits oil to flow from the buffer system to the governor sump. This will lower the oil pressure in the buffer system. The power spring will force the power piston down in the direction to decrease fuel.

As the buffer piston moves in the direction of the oil flow (from power cylinder to pilot valve), the right hand buffer spring is compressed and the left hand spring is relieved. This produces a pressure in the trapped oil on the left side of the buffer piston which is higher than the intermediate oil pressure on the right. The pressure is proportional to the displacement of the buffer piston and spring.

Simultaneously with the power piston and buffer piston movement these pressures will be transmitted to the compensating land. The higher pressure on the upper side of the land causes a downward force. This will increase until, added to the downward force of the speeder spring, it balances the flyweight force. It will also lower the pilot valve plunger enough to cover the regulating port and return the flyweights to the vertical position. As the regulating port is covered, the power piston will stop at a new position. This will correspond to the reduced amount of fuel required to operate the engine at the desired lower speed. The engine will be still decelerating toward the new speed setting.

As the centrifugal force of the flyweights decreases with engine deceleration, the downward oil force at the compensating land will again be reduced to zero. This is caused by the equalization of the oil pressures in the buffer system through the compensating needle valve. With the needle valve correctly adjusted, the oil pressure will equalize at the same rate as the decrease of centrifugal force in the flyweights. The flyweights will remain in the vertical position, keeping the regulating port covered by the control land of the pilot valve and holding the power piston stationary at the new position. Again, the buffer piston will be returned to center by the action of the buffer springs.

The engine will now be running at a lower speed with a reduced fuel setting.

Bypass passages are provided in the buffer cylinder to facilitate large corrective movements of the power piston. A large increase or decrease in the speed setting of the governor or a large increase or decrease of load on the engine will require a correspondingly large movement of the power piston to make the necessary correction to the fuel setting. Under such conditions, the buffer piston will move only far enough to the left or right to effect an opening at the bypass port (pressure or drain). Oil will then flow directly to or from the power cylinder through the bypass passage without further increasing the differential oil pressure force existing on the compensating land.

As soon as sufficient governor movement and fuel correction has occurred to effect a correction of engine speed towards the speed at which the governor is set, the differential oil pressure which is still present will act on the compensating land to recenter the pilot valve plunger.

With a large decrease in speed the power piston assembly moves to the "no fuel" position. This closes the compensating oil passage from the power cylinder to the compensating needle valve. It blocks passage of oil from the left end to the right end of the buffer cylinder, so that the needle valve cannot equalize buffer oil pressures in the usual manner. The buffer piston will have moved off center to the right and will be held there by the oil trapped between the power piston and the buffer piston.

The higher pressure of the oil on the left side of the buffer piston produced by the compression of the right hand buffer spring will act on the compensating land. It will add to the effect of the speeder spring setting and provide a temporary higher speed setting of the governor.

As the engine decelerates to a speed slightly below this higher speed setting, the governor will respond to raise the power piston and restore fuel supply in the normal manner. This will uncover the port to permit passage of oil through the compensating needle valve so that the governor and the engine will stabilize at the speed corresponding to the actual speed setting of the governor. This minimizes possible under-speeding of the engine when a large speed decrease occurs.

> **NOTE:** *The location of the compensation oil opening in the power cylinder wall makes it necessary to adjust the fuel linkage so that at IDLE SPEED, NO LOAD the PISTON GAP does not exceed 1-1/32 in.*

In actual practice the sequence of events occurring in the governor take place more or less in a simultaneous manner rather than step-by-step as described in the foregoing paragraphs.

LOAD CONTROL, LOAD CONTROL TIMING AND OVERRIDING MECHANISMS

The basic parts of the load control are the resistor-servomotor assembly and the load control pilot valve. These parts are shown in Fig. 1 and 2.

The resistor-servomotor assembly is equipped with a resistor having a number of taps. Each is connected by a wire to the segments of a commutator tap switch. Two commonly connected brush contacts are rotated to various positions around the commutator by a vane servomotor to change the electrical resistance of the resistor assembly and, through the generator excitation circuit, affect a change in engine load. When in operation, the resistor and commutator assemblies are cooled by being completely immersed in governor oil.

The vane servomotor is attached to the side plate opposite the resistor tap switch. It is connected to the load control pilot valve by oil passages in the side plate and governor column.

The load control pilot valve is suspended from an approximately central (adjustable) position in the linkage connecting the top of the power piston tail rod to the top of the speed setting piston rod. Any movement of the speed setting piston, power piston, or both, will cause a corresponding movement of the load control pilot valve in its stationary bushing. Pressure oil from the governor accumulators is supplied to the load control pilot valve through ports in its bushing. Two lands on the pilot valve control the flow of pressure oil to the vane servomotor and the flow of return oil from the vane servomotor to the governor sump.

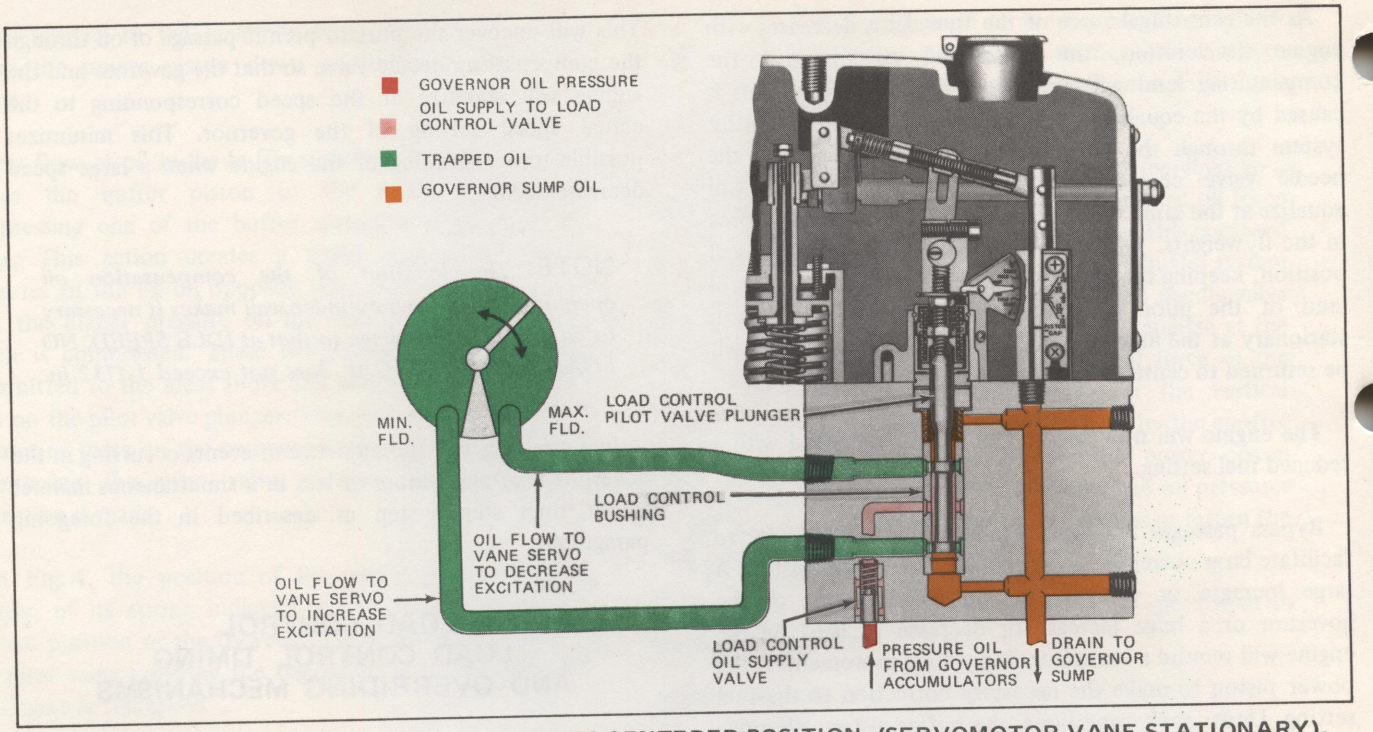

🟥 GOVERNOR OIL PRESSURE
▨ OIL SUPPLY TO LOAD CONTROL VALVE
🟩 TRAPPED OIL
🟧 GOVERNOR SUMP OIL
MIN. FLD.
MAX. FLD.
LOAD CONTROL PILOT VALVE PLUNGER
LOAD CONTROL BUSHING
OIL FLOW TO VANE SERVO TO DECREASE EXCITATION
OIL FLOW TO VANE SERVO TO INCREASE EXCITATION
LOAD CONTROL OIL SUPPLY VALVE
PRESSURE OIL FROM GOVERNOR ACCUMULATORS
DRAIN TO GOVERNOR SUMP
FIG. 5, E-11793B

FIG. 5. LOAD CONTROL PILOT VALVE IN ITS CENTERED POSITION (SERVOMOTOR VANE STATIONARY).

OPERATION OF THE LOAD CONTROL

With Load Increase

1. Fig. 5 illustrates the load control pilot valve in its "centered" position, with the control ports closed. If the train is in motion, the load on the generator plus the load applied by the auxiliary equipment is equal to the horsepower output of the engine at the existing speed of the engine. The engineer does not change the speed setting. The air compressor supplying the brake system begins pumping to replenish the system.

2. This added load is transmitted to the engine, the engine slows down and the governor operates to increase fuel to the engine by an upward movement of the power piston. This is the basic governor action previously described under Speed Control section.

3. In Fig. 6 the power piston has moved to an increased fuel position needed to bring the engine back to the desired speed as set by the governor, but the engine is now carrying more load than desired for the existing speed setting. However, the upward movement of the power piston has raised the right end of the load control linkage, and this has raised the load control pilot valve above center.

4. Pressure oil now flows through the load control bushing and out through the upper port to the vane servomotor. This causes the servomotor vane to rotate in a direction to reduce the generator excitation and thus reduces the load imposed by the generator on the engine.

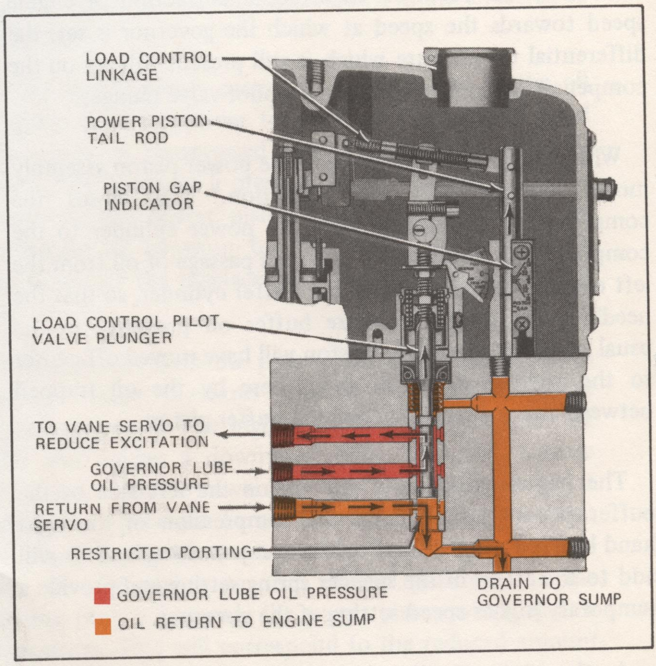

LOAD CONTROL LINKAGE
POWER PISTON TAIL ROD
PISTON GAP INDICATOR
LOAD CONTROL PILOT VALVE PLUNGER
TO VANE SERVO TO REDUCE EXCITATION
GOVERNOR LUBE OIL PRESSURE
RETURN FROM VANE SERVO
RESTRICTED PORTING
DRAIN TO GOVERNOR SUMP
🟥 GOVERNOR LUBE OIL PRESSURE
🟧 OIL RETURN TO ENGINE SUMP

FIG. 6. LOAD CONTROL PILOT VALVE RAISED ABOVE CENTER (SERVOMOTOR VANE ROTATES TO MINIMUM FIELD POSITION).

5. With this reduction in load, the engine speed will increase and the governor will operate to reduce fuel to the engine by a downward movement of the power piston.

6. Reduction of the field excitation current and of the fuel to the engine will continue simultaneously until the speed of the engine has returned to the set point and the power piston has returned to its original position. This will lower the right hand end of the load control linkage.

The load control pilot valve will again be centered, covering the control ports and stopping the movement of the vane servomotor.

In responding to the off-speed of the engine and attempting to correct the fuel setting, the governor has operated the load control pilot valve in the direction to reduce the generator field excitation. It has also reduced the generator load by an amount equal to the added load imposed by the air compressor. Therefore, the horsepower demand on the engine has returned to the designated point for the existing speed setting of the governor.

With Load Decrease

When the air system is filled and the air compressor stops pumping without any change made in the speed setting of the governor, the action of the load control mechanism will be the reverse of that described in the preceding paragraphs.

1. The decrease in mechanical load at the air compressor will reduce the total load on the engine, and engine speed will increase. The governor will now operate to reduce fuel to the engine.

2. The downward movement of the power piston will lower the right end of the load control linkage, and the pilot valve will move down below center. Pressure oil will flow through the lower port in the bushing to the vane servomotor to effect an increase in the generator field excitation current and thus increase the total load on the engine.

3. With this added load, the engine speed will be lowered and the governor will respond to increase the fuel by raising the power piston.

4. Raising the field excitation current and increasing the fuel to the engine will continue simultaneously until the power piston has returned to its original position. This will raise the right end of the load control linkage and the pilot valve to the point where the ports in the bushing are again closed to stop movement of the vane servomotor.

5. At the end of this sequence the engine speed and fuel supply will have returned to their original setting. The engine loading will be correct for the existing speed setting of the governor.

With Increased Speed Setting

1. The engineer moves the Throttle handle to a higher notch, raising the speed setting of the governor, and the speed setting piston moves downward.

2. This will lower the left end of the load control linkage and move the load control pilot valve below center. Pressure oil will flow out of the lower port to the vane servomotor to move the potentiometer brush arm in the direction to increase excitation. Return oil from the vane servomotor will flow back through the upper control port to the governor sump.

3. With a higher speed setting the governor operates to increase the fuel supply and the power piston will move up. This will raise the right end of the load control linkage to return the load control pilot valve to center and stop the movement of the vane servomotor.

4. At the end of this sequence the fuel supply, engine speed and field excitation has been increased. There is a resultant increase of engine horsepower output and generator output, to provide the correct loading for the new speed setting.

With Decreased Speed Setting

1. Moving the Throttle handle to a lower notch decreases the speed setting of the governor, and the speed setting piston moves up.

2. The left end of the load control linkage is raised and the load control pilot valve is moved above center. Pressure oil flows through the upper port to the vane servomotor to move the potentiometer brush arm in the direction to reduce excitation. Return oil from the servomotor flows back through the lower control port to the governor sump.

3. With a lower speed setting the governor operates to decrease the fuel supply, and the power piston moves down. This lowers the right end of the load control linkage to return the load control pilot valve to its centered position and stop the movement of the vane servomotor.

4. At the end of this sequence the fuel supply, engine speed and field excitation will have been decreased with a resultant decrease of engine horsepower output and generator output, again providing the correct loading for the new speed setting.

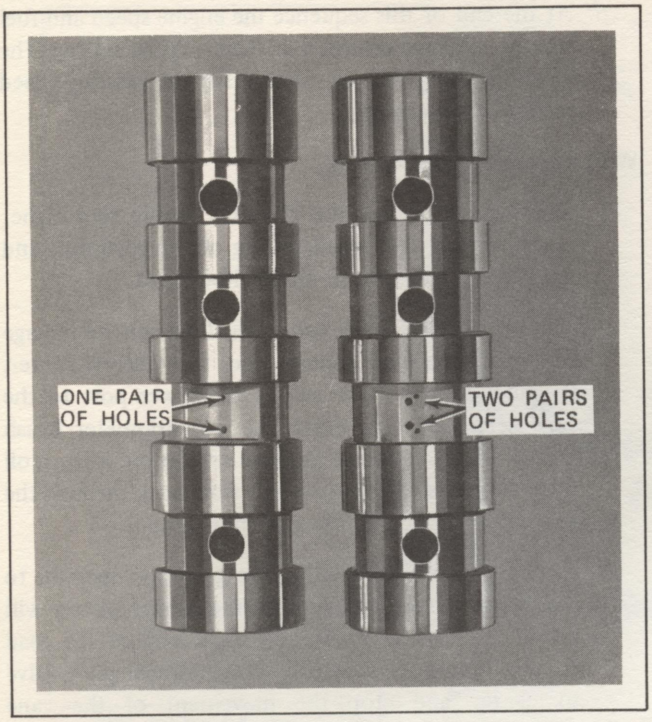
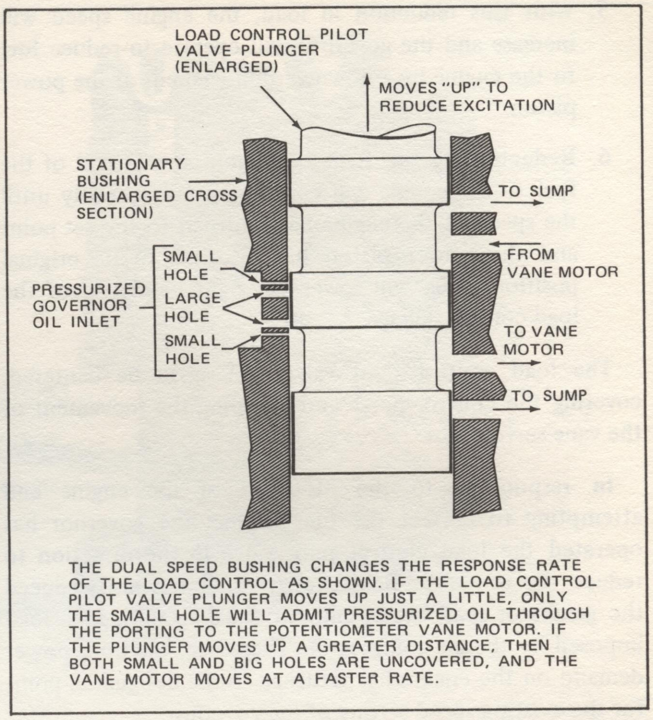


FIG. 7A. DUAL-SPEED AND SINGLE-SPEED LOAD CONTROL PILOT VALVE BUSHINGS.

FIG. 7A, E-21280A


LOAD CONTROL PILOT VALVE PLUNGER (ENLARGED)
MOVES "UP" TO REDUCE EXCITATION
STATIONARY BUSHING (ENLARGED CROSS SECTION)
TO SUMP
SMALL HOLE
LARGE HOLE
SMALL HOLE
PRESSURIZED GOVERNOR OIL INLET
FROM VANE MOTOR
TO VANE MOTOR
TO SUMP

THE DUAL SPEED BUSHING CHANGES THE RESPONSE RATE OF THE LOAD CONTROL AS SHOWN. IF THE LOAD CONTROL PILOT VALVE PLUNGER MOVES UP JUST A LITTLE, ONLY THE SMALL HOLE WILL ADMIT PRESSURIZED OIL THROUGH THE PORTING TO THE POTENTIOMETER VANE MOTOR. IF THE PLUNGER MOVES UP A GREATER DISTANCE, THEN BOTH SMALL AND BIG HOLES ARE UNCOVERED, AND THE VANE MOTOR MOVES AT A FASTER RATE.

FIG. 7B. PARTIAL CROSS SECTION OF DUAL-SPEED LOAD CONTROL PILOT VALVE.

FIG. 7B, E-21279

LOAD CONTROL TIMING

The balanced action between the governor speed control and load control potentiometer is established by controlling the rate of movement of the vane servomotor in both the direction to increase and decrease excitation. In G-E governor applications, the rate of movement of the vane servomotor is non-adjustable. In such cases, rate of movement in both the increasing and decreasing excitation direction is fixed by the number, size and position of a group of orifice holes in the load control pilot valve bushing. These holes are opened and closed by movement of the pilot valve plunger.

With appropriate positioning and sizing of the orifice holes in the bushing, it is also possible to obtain a dual rate of load control timing. This arrangement provides a fast initial rate of servomotor movement followed by a slower rate, which minimizes the possibility of over-shooting the desired position of the potentiometer. See Fig. 7A and 7B.

A spring-loaded valve is used in the oil supply line to the load control pilot valve bushing to assist in reducing cranking time when the engine is started (see Fig. 5.) This oil supply valve remains closed when cranking the engine and while governor oil pressure is building up, so that all oil delivered by the governor pump is available to lift the power piston and supply fuel to the engine cylinders. After the engine starts, the governor oil pressure quickly increases, forcing the oil supply valve open, permitting normal operation of the load control mechanism. A pressure drop always appears across this valve. In some cases it is used by specific spring loading to adjust the pressure of the oil supplied to the load control system. Thus, when used with the orificed control bushing, it will further regulate the rate of movement of the vane servomotor.

OVERRIDING MECHANISM

To improve the operating characteristics of the locomotive, under certain conditions, it is desirable to override the normal action of the load control to affect a temporary reduction in generator output by reducing the generator field excitation.

Examples of these conditions are:

1. To provide a smooth "transition" when, at certain train speeds, the motor connections are changed from series parallel to full parallel. This change is required to provide correct transmission of the electrical power.
2. To assist in stopping wheelslip which occurs as a result of rail or load conditions.
3. When the locomotive is operated in multiple unit with its own kind, or in most instances, when operated as a trailing unit with a locomotive of another design

FIG. 8, E-11796

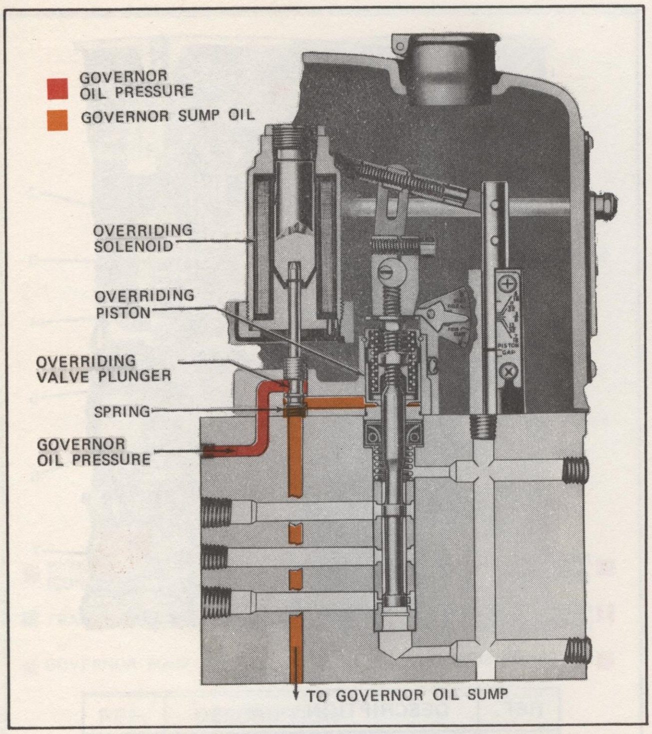

🟥 GOVERNOR OIL PRESSURE
🟧 GOVERNOR SUMP OIL
OVERRIDING SOLENOID
OVERRIDING PISTON
OVERRIDING VALVE PLUNGER
SPRING
GOVERNOR OIL PRESSURE
TO GOVERNOR OIL SUMP

FIG. 8. OVERRIDING SOLENOID DE-ENERGIZED. LOAD CONTROL PILOT VALVE IN NORMAL OPERATING POSITION.

leading, the overriding mechanism functions during dynamic braking as a remote, proportional control. That is, it controls the braking effort of the unit in proportion to a signal received from the lead unit.

4. To reduce generator output as a function of the power matching device on locomotives so equipped.

5. To hold the vane servomotor and field rheostat in minimum field position while the engine is operating at IDLE in applications where the load control system is adjusted for "maximum field start." This arrangement is termed "Modified Maximum Field Start".

The overriding mechanism shown in Fig. 8 and 9 consists of a piston within a cylinder around the upper end of the load control pilot valve and a solenoid-operated oil control valve which, when energized, allows governor pressure oil to flow into the cylinder and under the piston. When the solenoid is de-energized the pressure oil is cut off and oil in the cylinder is allowed to drain to the sump.

Fig. 8 shows the load control pilot valve centered or "balanced" with the engine and generator operating at a steady speed with a steady load. The overriding solenoid is de-energized, the overriding valve plunger is held up by its spring, and the overriding cylinder is connected to the governor sump with the overriding piston resting on the bottom of its cylinder.

FIG. 9, E-11797

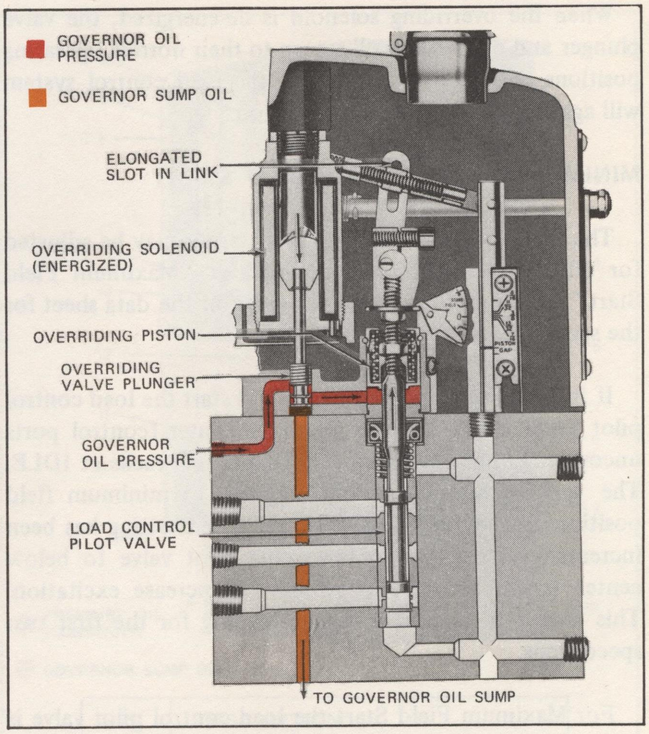

🟥 GOVERNOR OIL PRESSURE
🟧 GOVERNOR SUMP OIL
ELONGATED SLOT IN LINK
OVERRIDING SOLENOID (ENERGIZED)
OVERRIDING PISTON
OVERRIDING VALVE PLUNGER
GOVERNOR OIL PRESSURE
LOAD CONTROL PILOT VALVE
TO GOVERNOR OIL SUMP

FIG. 9. OVERRIDING SOLENOID ENERGIZED. LOAD CONTROL PILOT VALVE MOVED ABOVE CENTER.

When the solenoid is energized as shown on Fig. 9, the valve plunger is pushed down, closing the drain to the sump and admitting governor pressure oil into the overriding cylinder. Thus, the piston is forced upward until it contacts the spring seat secured to the pilot valve stem. Continued upward movement raises the load control pilot valve above center, permitting flow of governor pressure oil to the vane servomotor in the direction to reduce excitation. Thus power output of the generator and the load on the engine is reduced. Lifting of the load control pilot valve by the overriding solenoid, independently of the load control linkage, is made possible by the use of the elongated slot in the link connecting the pilot valve to the linkage.

A "fast unloading" arrangement is also affected whenever the overriding solenoid is energized, moving the load control pilot valve upward to its full travel. This is accomplished through the use of an additional control land at the bottom end of the load control pilot valve which, with the pilot valve fully lifted, uncovers a drain port. This allows oil draining from the vane servomotor to bypass the adjustable ball valves or restricted porting in the pilot valve bushing which normally control the rate of movement of the vane servomotor. This results in a fast movement of the vane servomotor and its potentiometer brush arm toward minimum field position.

When the overriding solenoid is de-energized, the valve plunger and pilot valve will return to their normal operating positions as shown in Fig. 8 and the load control system will again assume its normal operation.

MINIMUM OR MAXIMUM FIELD START

The load control system in the governor may be adjusted for either "Minimum Field Start" or "Maximum Field Start" according to information given in the data sheet for the specific governor application.

If it is arranged for minimum field start the load control pilot valve is adjusted to be above center (control ports uncovered) with the speed setting and fuel racks at IDLE. The vane servomotor will then move to minimum field position and remain there until the speed setting has been increased sufficiently to lower the pilot valve to below center (control ports uncovered) to increase excitation. This results in minimum engine loading for the first two speed steps.

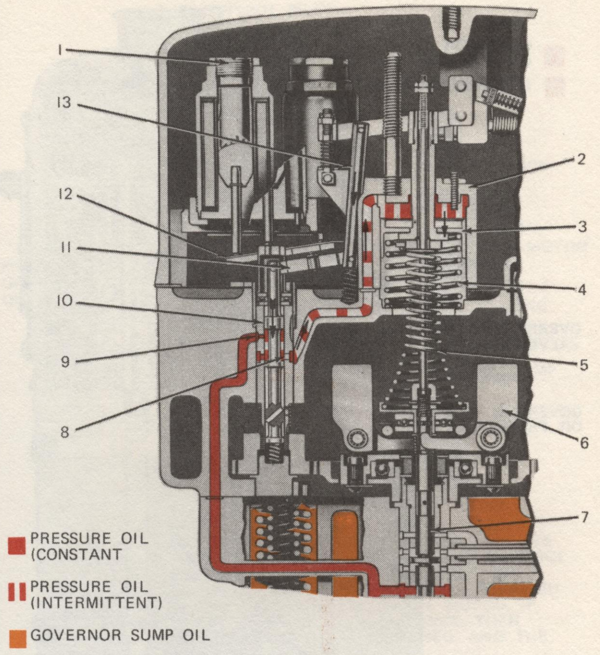
For Maximum Field Start the load control pilot valve is adjusted to be below center with the speed setting and fuel rack at IDLE. The vane servomotor will then be at maximum field position as the Throttle handle is moved to the 1st notch. The load will build up until the governor power piston moves the load control pilot valve to or above center to adjust the field excitation current to provide the correct engine loading for the existing speed setting.

An arrangement termed "Modified Maximum Field Start" is also commonly used. In this arrangement the load control pilot valve is adjusted for Maximum Field Start as described above. This would normally position the vane servomotor to provide maximum field excitation on entering the 1st notch. However, in operation, the overriding solenoid is automatically energized when the Throttle handle is at IDLE, to raise the pilot valve and position the vane servomotor at minimum field. As the throttle handle is moved to the 1st notch the overriding solenoid is de-energized, allowing the load control device to function to increase excitation toward maximum as the train starts.

SPEED SETTING, SPEED CHANGING AND NORMAL SHUTDOWN

GENERAL

Speed adjusting in the governor is effected by changing the spring force of the speeder spring opposing the flyweights. This is accomplished by means of the speed setting piston in the speed setting cylinder which is positioned directly over the governor speeder spring. (See Fig. 10, 11 and 12.) Downward movement of the speed setting piston to a higher speed setting is obtained by admitting governor pressure oil to the speed setting cylinder above the piston. Upward movement of the piston to a lower speed setting is obtained by draining oil away from the speed setting cylinder, allowing the speed setting piston spring to raise the piston as oil is drained out.



REF.	DESCRIPTION
1	SPEED SOLENOIDS
2	SPEED SETTING CYLINDER
3	SPEED SETTING PISTON
4	SPEED SETTING PISTON SPRING
5	SPEEDER SPRING
6	FLYWEIGHTS
7	GOVERNOR PILOT VALVE
8	REGULATING PORT
9	INTERMITTENT SUPPLY PORT
10	SPEED SETTING PILOT VALVE
11	FLOATING LEVER
12	TRIANGULAR PLATE
13	RESTORING LINK

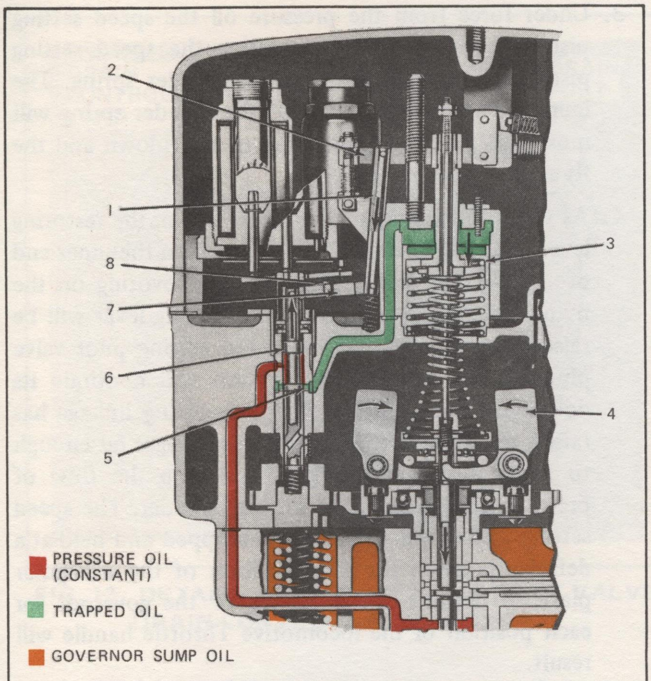
FIG. 10. SPEED SETTING PILOT VALVE ACTION TO INCREASE SPEED. VALVE PLUNGER BELOW CENTER.

FIG. 10, E-11798

Flow of governor oil to and from the speed setting cylinder is controlled by the speed setting pilot valve plunger, contained in its rotating bushing. Both are actuated by the electric solenoids to provide "step" control at 8 predetermined speeds from idle to full speed plus a normal shutdown position. Rotation of the speed setting pilot valve bushing is obtained through a large drive gear which is part of the flyweight head and a driven gear into which the splined lower end of the bushing is inserted.

FIG. 11, E-11799

FIG. 12, E-11800

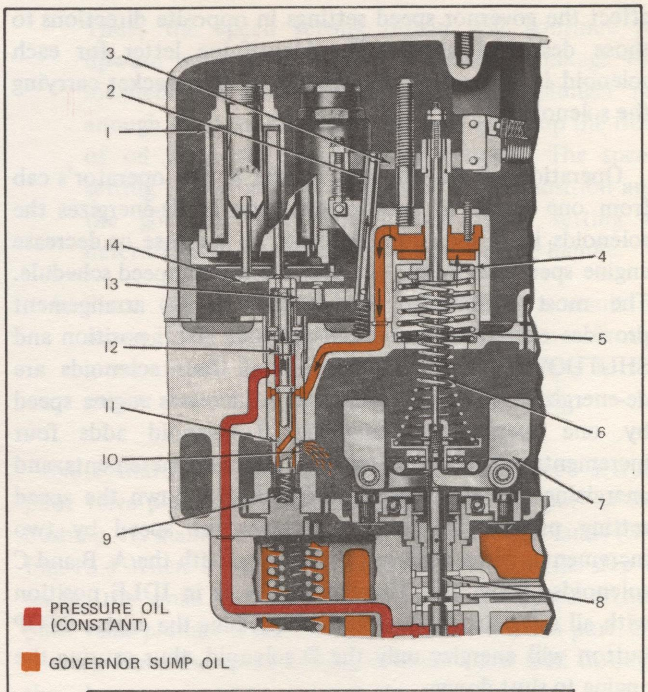


REF.	DESCRIPTION
1	RESTORING LINK
2	RESTORING LEVER
3	SPEED SETTING PISTON
4	FLYWEIGHTS
5	REGULATING PORT
6	SPEED SETTING PILOT VALVE
7	FLOATING LEVER
8	NYLON PIN

FIG. 11. SPEED SETTING PILOT VALVE RESTORING ACTION. VALVE PLUNGER RETURNED TO CENTERED POSITION.

The rate of movement of the speed setting piston in the downward direction to increase the speed setting and thus acceleration of the engine, is adjusted to a certain time in seconds. This is done by admitting governor pressure oil into the rotating speed setting pilot valve bushing through a sized port which registers with the supply port once in each revolution of the bushing. (See Fig. 10.) The size of this intermittent supply port will differ between governors according to the engine model and the locomotive application.

With the governor properly adjusted, correct positioning of the speed setting piston, when a speed setting change is made, is obtained through the use of "restoring" linkage between the speed setting piston and the speed setting pilot valve plunger. As the speed setting piston moves to a new speed setting this linkage returns the speed setting pilot valve plunger to its closed port position, stopping the flow of oil to or from the speed setting cylinder. This results in holding the speed setting piston at the proper position for the particular speed setting. Movements of the restoring linkage is shown by arrows in Fig. 10, 11 and 12.



REF.	DESCRIPTION
1	SPEED SOLENOIDS
2	RESTORING LINK
3	RESTORING LEVER
4	SPEED SETTING PISTON
5	SPEED SETTING PISTON SPRING
6	SPEEDER SPRING
7	FLYWEIGHTS
8	GOVERNOR PILOT VALVE
9	PILOT VALVE SPRING
10	DRAIN PORT
11	DRAIN CONTROL LAND
12	SPEED SETTING PILOT VALVE
13	FLOATING LEVER
14	TRIANGULAR PLATE

FIG. 12. SPEED SETTING PILOT VALVE ACTION TO DECREASE SPEED. VALVE PLUNGER ABOVE CENTER.

SPEED CHANGING MECHANISM

Three solenoids, A, B and C, actuate the speed setting pilot valve by controlled movements of the triangular plate and connecting linkage, while a fourth solenoid, D, works directly on the speed setting pilot valve bushing. Energizing the A, B or C solenoids singly or in combination pushes down on the triangular plate and results in a downward movement of the speed setting pilot valve plunger. This opens the regulating port to passage of the intermittent pressure oil to the speed setting cylinder which effects an increase in speed setting. (See Fig. 10 and 11.) Energizing the D solenoid causes a shutdown movement of the speed setting pilot valve bushing. This opens the regulating port to allow oil from the speed setting cylinder to drain out and return to the governor sump, thus resulting in a decrease in speed setting. (See Fig. 12.) De-energizing the solenoids will affect the governor speed settings in opposite directions to those described above. The identifying letter for each solenoid is marked on the surface of the bracket carrying the solenoids.

Operation of the Throttle handle in the operator's cab from one notch to another energizes or de-energizes the solenoids in various combinations, to increase or decrease engine speed according to a pre-determined speed schedule. The most commonly used speed setting arrangement provides eight load speed settings plus IDLE position and SHUTDOWN. At IDLE position all four solenoids are de-energized. Energizing solenoid A increases engine speed by one increment; energizing B solenoid adds four increments; energizing C solenoid adds two increments; and energizing the D solenoid, which pushes down the speed setting pilot valve bushing, reduces the speed by two increments, when used in combination with the A, B and C solenoids. When the Throttle handle is in IDLE position with all solenoids de-energized, depressing the engine STOP button will energize only the D solenoid, thus causing the engine to shut down.

CONDITIONS OF OPERATION

Equilibrium Condition (Fig. 3)

1. The engine is running at low speed as indicated by the de-energized solenoids and the speed setting piston in its upper position.
2. The speed setting pilot valve plunger is centered with the control land covering the regulating port, trapping the oil above the speed setting piston and holding the piston in a fixed position representing a certain speed.
3. The engine is on speed as indicated by the vertical position of the flyweights.

Speed Setting Increase (Fig. 10)

1. One or a combination of the solenoids is energized by moving the Throttle handle to a higher notch.
2. The solenoid plungers move down and the plunger rods move the triangular plate to a lower position. This results in a downward movement at the bi-metal strip* transmitted to the nylon pin in the floating lever. This lever, pivoting at the lower end of the restoring link, moves the speed setting pilot valve plunger down, opening the regulating port to permit passage of governor pressure oil to the speed setting cylinder (intermittent supply). See Fig. 10.
3. Under force from the pressure oil the speed setting piston moves down, compressing the speed setting piston spring and the governor speeder spring. The increased downward force of the speeder spring will move the governor pilot valve plunger down and the flyweights inward.
4. As the speed setting piston moves down, the restoring lever and link operate to push down on the inner end of the floating lever. (See Fig. 11.) Pivoting on the nylon pin the outer end of the floating lever will be raised, carrying with it the speed setting pilot valve plunger. The speed setting piston will continue its downward movement until the restoring linkage has raised the speed setting pilot valve plunger far enough to close the regulating port and stop the flow of pressure oil to the speed setting cylinder. The speed setting piston will therefore be stopped and held at a definite position for each position of the triangular plate. A definite speed setting of the governor for each position of the locomotive Throttle handle will result.
5. Since the flyweights move inward when the speeder spring force is increased, as a result of moving the Throttle handle to a higher notch, the governor will act to increase the fuel supply to the engine and increase the speed.

Speed Setting Decrease (Fig. 12)

1. One or more of the solenoids will be de-energized (or energized) by moving the Throttle handle to a lower notch.
2. The triangular plate will follow the movement of the solenoid plunger rods to a higher position.

NOTE: *The triangular plate is held up in contact with the solenoid plunger rods at all times by a spring located centrally under the plate, around the top of the "bypass valve" case. See Fig. 14.*

3. With the floating lever pivoting at the lower end of the restoring link, the spring under the speed setting pilot valve will raise the valve and the outer end of the floating lever, holding the nylon button in contact with the bi-metal strip. This action opens the regulating port to permit passage of the oil above the speed setting piston back through the speed setting pilot valve bushing and out through a drain port into the governor sump. (See Fig. 12.)
4. As the oil drains out from above the speed setting piston, the piston return spring will force the speed setting piston up and reduce the downward force of the speeder spring. This will allow the flyweights to move outward and raise the governor pilot valve plunger.

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*The bi-metal strip is used in the speed setting mechanism of the governor to minimize the effect of temperature changes on the governor speed settings.

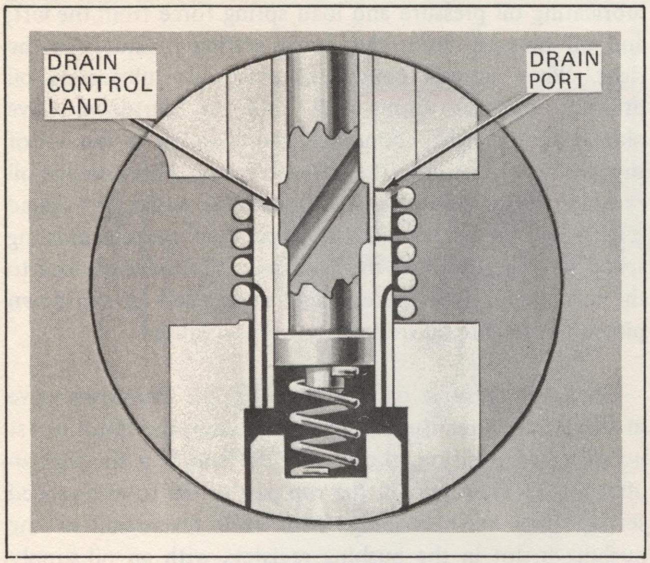

DRAIN CONTROL LAND
DRAIN PORT

FIG. 13, E-11801

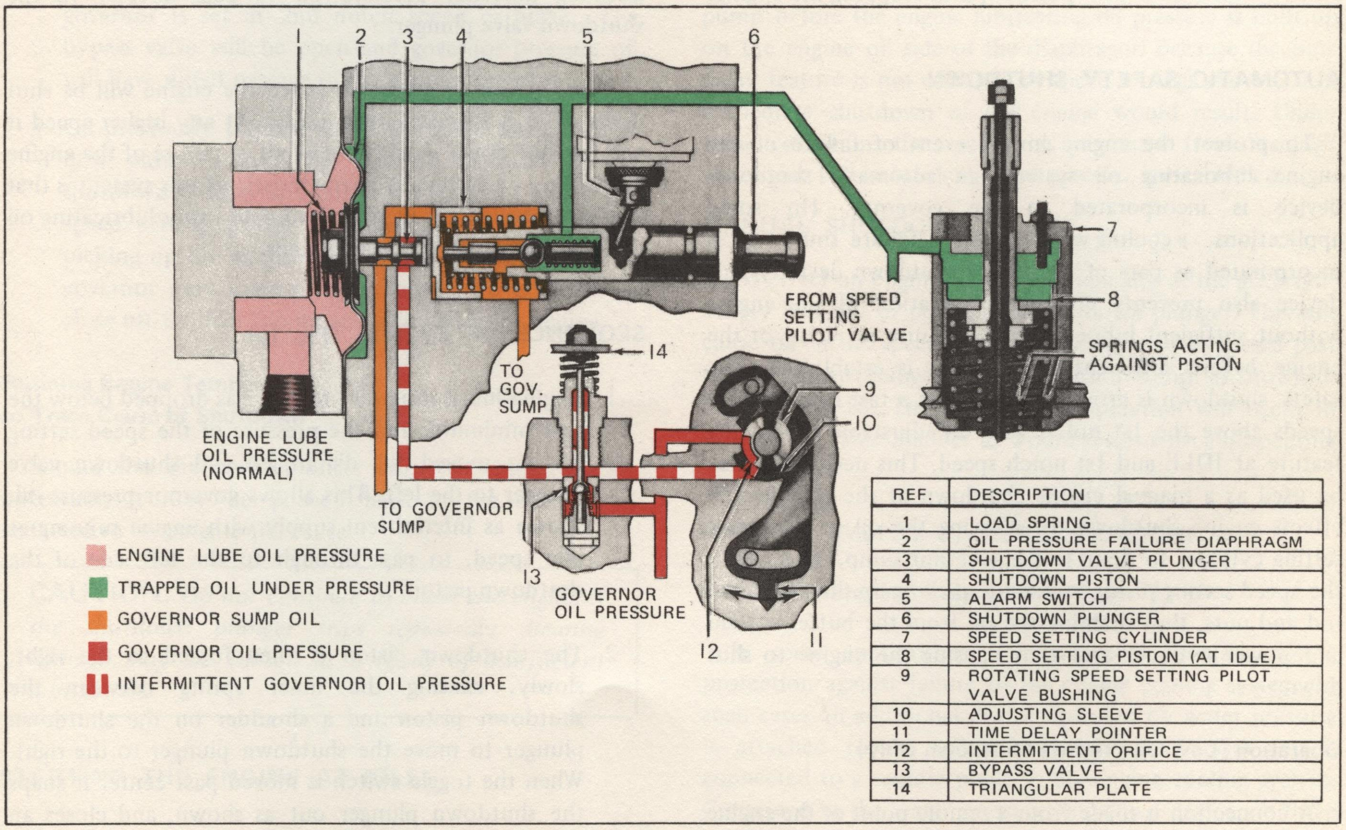
FIG. 13. DETAILS OF SPEED SETTING PILOT VALVE DRAIN CONTROL LAND AND PORT.

5. As the speed setting piston moves up, the restoring lever and link operate to raise the inner end of the floating lever. Pivoting on the nylon pin, the outer end of the floating lever will move down and the speed setting pilot valve plunger will be moved down. Thus, the speed setting piston will continue its upward movement until the restoring linkage has lowered the speed setting pilot valve plunger far enough to close the regulating port and stop the flow of oil from the speed setting cylinder. The speed setting piston will be stopped at a new position and the governor will have a new speed setting as determined by the position of the Throttle handle.

6. Since the flyweights move outward as a result of moving the Throttle handle to a lower notch, the governor will act to decrease the fuel supply to the engine and reduce the engine speed.

Note that the drain control land of the speed setting pilot valve plunger normally overlaps the drain port in the bushing. Its diameter is a little less than the other lands (See Fig. 13.) When a speed reduction of one throttle step is made, the small upward movement of the speed setting pilot valve plunger is not enough to open the drain port. Oil coming from the speed setting cylinder must leak through the clearance existing around the drain control land in order to pass through the drain port.

Consequently, the rate at which the governor speed setting can be reduced one step is quite slow. For a two (or


1
2
3
4
5
6
7
8
9
10
11
12
13
14
FROM SPEED SETTING PILOT VALVE
SPRINGS ACTING AGAINST PISTON
TO GOV. SUMP
ENGINE LUBE OIL PRESSURE (NORMAL)
TO GOVERNOR SUMP
GOVERNOR OIL PRESSURE
ENGINE LUBE OIL PRESSURE
TRAPPED OIL UNDER PRESSURE
GOVERNOR SUMP OIL
GOVERNOR OIL PRESSURE
INTERMITTENT GOVERNOR OIL PRESSURE

REF.	DESCRIPTION
1	LOAD SPRING
2	OIL PRESSURE FAILURE DIAPHRAGM
3	SHUTDOWN VALVE PLUNGER
4	SHUTDOWN PISTON
5	ALARM SWITCH
6	SHUTDOWN PLUNGER
7	SPEED SETTING CYLINDER
8	SPEED SETTING PISTON (AT IDLE)
9	ROTATING SPEED SETTING PILOT VALVE BUSHING
10	ADJUSTING SLEEVE
11	TIME DELAY POINTER
12	INTERMITTENT ORIFICE
13	BYPASS VALVE
14	TRIANGULAR PLATE

FIG. 14, E-11802

FIG. 14. AUTOMATIC SAFETY SHUTDOWN WITH ENGINE OIL PRESSURE PROTECTION ONLY. NORMAL OPERATING CONDITION.

more) step reduction, the pilot valve plunger will move up enough to open the drain port below the drain control land. Oil from the speed setting cylinder can pass freely through the diagonal hole and out through the drain port to the governor sump, permitting a faster decrease of governor speed setting.

NORMAL SHUTDOWN

Under normal operating conditions the engine is shut down by moving the Throttle handle to IDLE and depressing the engine STOP button in the operator's cab. This, in turn, energizes the D solenoid alone, which pushes down the speed setting pilot valve bushing and opens the regulating port to permit passage of oil from the speed setting cylinder to the governor sump.

With only the D solenoid energized, the restoring linkage cannot re-center the speed setting pilot valve to close the regulating port before the speed setting piston has moved up to its stop screw. At this point, the shutdown nuts and shutdown rod will have been raised 1/64 in. Raising the shutdown rod raises the governor pilot valve plunger, opening the governor regulating port to permit flow of regulating oil from the buffer system to the governor sump. This will allow the power spring to force the power piston down to the FUEL OFF position, thus stopping the engine.

AUTOMATIC SAFETY SHUTDOWN

To protect the engine in the event of failure of the engine lubricating oil system, an automatic shutdown device is incorporated in the governor. (In some applications, a cooling water pressure failure shutdown is incorporated as part of the safety shutdown device.) This device also prevents prolonged operation of the engine without sufficient lubricating oil pressure or racing of the engine before sufficient oil pressure is established. The safety shutdown is arranged to provide a fast shutdown at speeds above the 1st notch with an adjustable time delay feature at IDLE and 1st notch speed. This device can also be used as a manual engine shutdown at the governor. It effects engine shutdown by allowing the oil in the speed setting cylinder to drain to the governor sump. As a result, the speed setting piston moves up, picking up the shutdown rod and nuts, thus draining the oil from the buffer system and power cylinder and thus causing the engine to shut down.

Operation (Low Oil Pressure Shutdown Only)

A connection is made from a remote point of the engine lubricating system to a diaphragm in the shutdown device shown in Fig. 14. This diaphragm is acted upon by engine lubricating oil pressure and load spring force from the left, and oil pressure from the speed setting cylinder on the right. When normal conditions exist, the lubricating oil pressure and the spring will hold the shutdown valve plunger to the right, connecting the chamber to the left of the shutdown piston to the governor sump. When engine oil pressure drops below a safe operating point, the speed setting oil pressure, which is dependent on the existing speed setting, will move the diaphragm and valve plunger to the left, connecting the chamber at the left of shutdown piston to pressure oil from the governor pump.

Governor pressure oil is supplied to the shutdown valve in two ways. When the triangular plate is in the IDLE or 1st notch speed position, the oil will be supplied through an intermittent flow port in the top part of the rotating speed setting pilot valve bushing. With each revolution of the bushing a slot in the bushing registers with an oil supply passage in the governor column and a hole in the adjusting sleeve, to pass a small volume of oil. (See Fig. 14.) By means of the time delay pointer, the sleeve may be turned so that the duration of the register may be adjusted to increase or decrease the volume of oil supplied. Turning the pointer clockwise will reduce tripping time. When the triangular plate is down in the 2nd notch or a higher speed position, the bypass valve is moved down off its seat, allowing governor pressure oil to pass directly to the shutdown valve plunger.

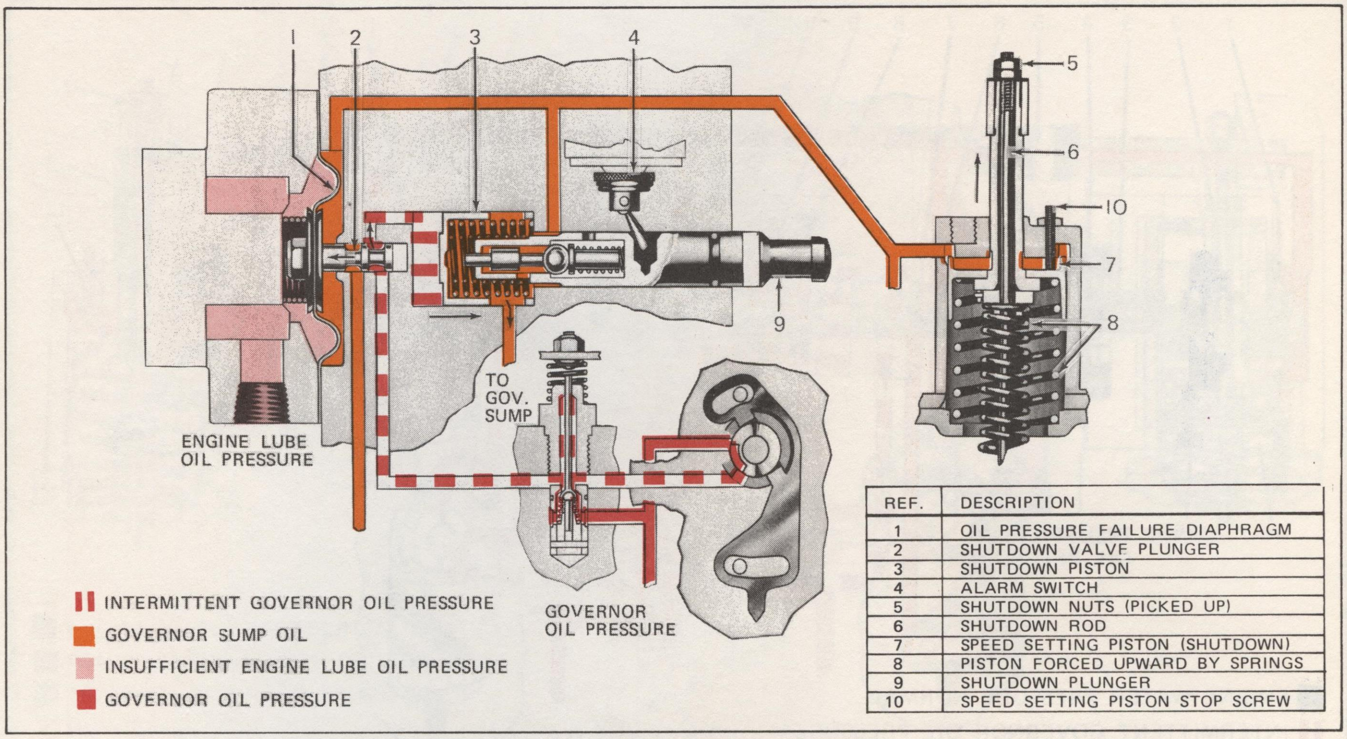
Thus, at idle or 1st notch speed the engine will be shut down after a specified time delay. At any higher speed it will be shut down quickly, in event of failure of the engine lubricating oil system. A characteristic of this system is that shutdown will occur at idle speed with lower lubricating oil pressures than at high engine speeds.

SEQUENCE OF EVENTS (Fig. 15)

1. Engine lubricating oil pressure has dropped below the safe minimum, and the pressure of the speed setting oil has moved the diaphragm and shutdown valve plunger to the left. This allows governor pressure oil, shown as intermittent supply with engine running at idle speed, to pass through to the left side of the shutdown piston.

2. The shutdown piston is then forced to the right, slowly, causing the inner spring between the shutdown piston and a shoulder on the shutdown plunger to move the shutdown plunger to the right. When the toggle switch is moved past center it snaps the shutdown plunger out as shown, and closes an alarm circuit, energizing the signal device in the operator's cab.

FIG. 15, E-11803A



REF.	DESCRIPTION
1	OIL PRESSURE FAILURE DIAPHRAGM
2	SHUTDOWN VALVE PLUNGER
3	SHUTDOWN PISTON
4	ALARM SWITCH
5	SHUTDOWN NUTS (PICKED UP)
6	SHUTDOWN ROD
7	SPEED SETTING PISTON (SHUTDOWN)
8	PISTON FORCED UPWARD BY SPRINGS
9	SHUTDOWN PLUNGER
10	SPEED SETTING PISTON STOP SCREW

FIG. 15. AUTOMATIC SAFETY SHUTDOWN WITH ENGINE OIL PRESSURE PROTECTION ONLY. ACTUATED TO CAUSE SHUTDOWN.

The shutdown piston will move to the right fast if the governor is set at 2nd notch speed or higher. The bypass valve will be open and governor pressure oil will have direct passage to the shutdown piston.

3. Oil previously trapped above the speed setting piston now passes around the reduced diameter of the shutdown plunger and out to the governor sump. The speed setting piston is forced up by the springs, picking up the shutdown nuts, shutdown rod and the governor pilot valve plunger, causing the governor to close off the fuel supply and shut down the engine.

Running Engine Temporarily to Trace Cause of Shutdown

Should the shutdown plunger snap out during engine operation, it may be pushed back in the engine and restarted to investigate the cause.

> CAUTION: *Do not continue to crank the engine if the shutdown plunger trips repeatedly. Bearing damage may be caused as a result of insufficient lubrication.*

STARTING THE ENGINE AT IDLE

The Throttle handle should always be set at IDLE when starting the engine. If set at a higher speed, the shutdown device will receive pressure oil direct from the governor pump before the engine lubricating oil pressure is built up on the engine oil side of the diaphragm. Because the time delay feature is not effective at speed settings above IDLE, immediate shutdown of the engine would result. Under these conditions the operator is prevented from "racing" the engine before lubricating oil pressure is established.

MANUAL SHUTDOWN

To effect an engine shutdown manually at the governor, simply pull out or push in the shutdown plunger. This will cause oil in the speed setting cylinder to be bypassed past the shutdown plunger to the governor sump, as shown in Fig. 15 and 16. The sequence of operation will occur in exactly the same manner as would result with a lubricating oil failure.

COOLING SYSTEM FAILURE SHUTDOWN

Common, Water and Lube Oil Shutdown Plunger

In some applications it is desirable to also provide protection against failure of the engine cooling system. In such cases an additional device operated by water pressure is attached to the safety shutdown mechanism and is connected to a remote point in the engine cooling system. Contained in the water pressure shutdown device are three diaphragms, a ball check valve and an adjustment screw. (See Fig. 17.)

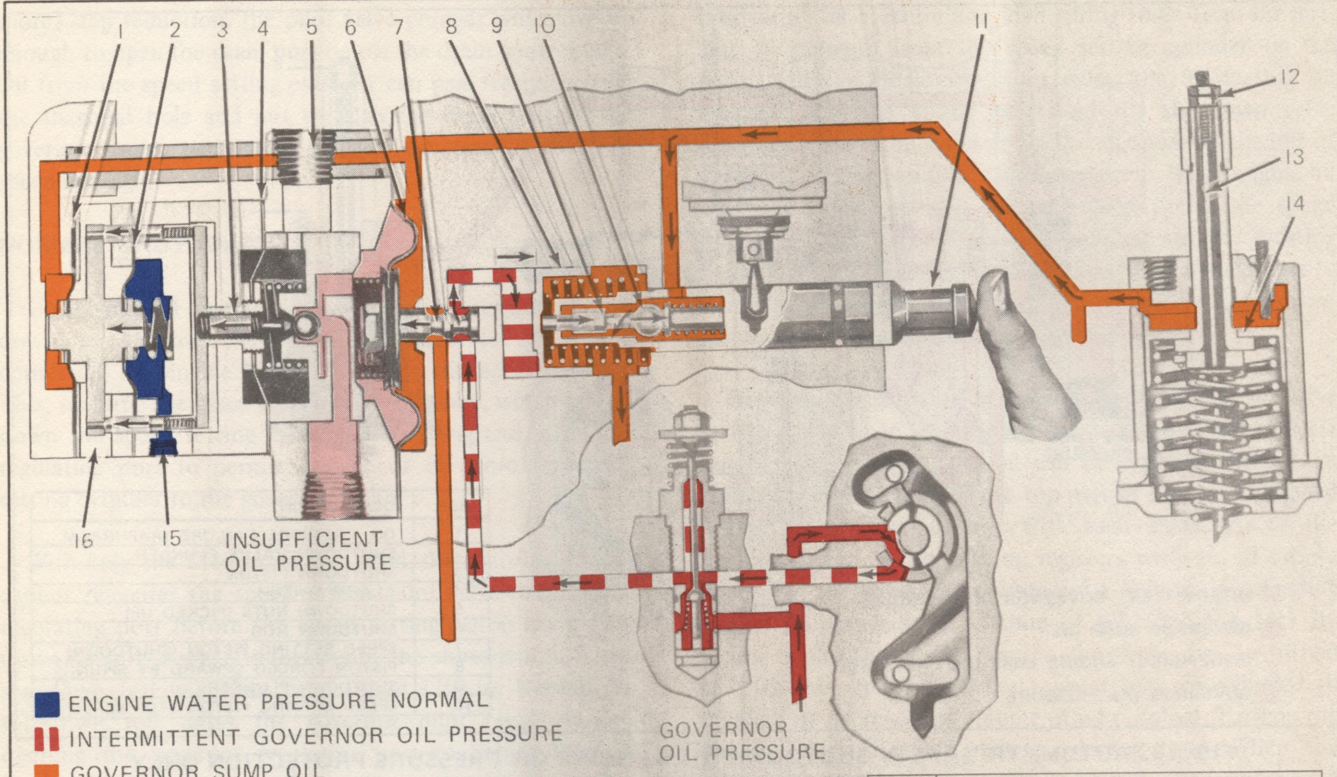


FIG. 16, E-11806

- 🟦 ENGINE WATER PRESSURE NORMAL
- ▥ INTERMITTENT GOVERNOR OIL PRESSURE
- 🟧 GOVERNOR SUMP OIL
- ▨ INSUFFICIENT ENGINE LUBE OIL PRESSURE
- 🟥 GOVERNOR OIL PRESSURE

REF.	DESCRIPTION
1	SPEED SETTING OIL DIAPHRAGM
2	WATER PRESSURE FAILURE DIAPHRAGM
3	SEALING DIAPHRAGM ADJUSTMENT SCREW
4	ENGINE OIL SEALING DIAPHRAGM
5	OIL DRAIN PORT TO ENGINE CRANKCASE
6	OIL PRESSURE FAILURE DIAPHRAGM
7	SHUTDOWN VALVE PLUNGER
8	SHUTDOWN PISTON
9	SHUTDOWN PLUNGER VALVE PIN
10	BALL VALVE (OPEN)
11	SHUTDOWN PLUNGER
12	SHUTDOWN NUTS
13	SHUTDOWN ROD
14	SPEED SETTING PISTON
15	ENGINE WATER SUPPLY PORT (PRESSURE NORMAL)
16	VENT TO ATMOSPHERE

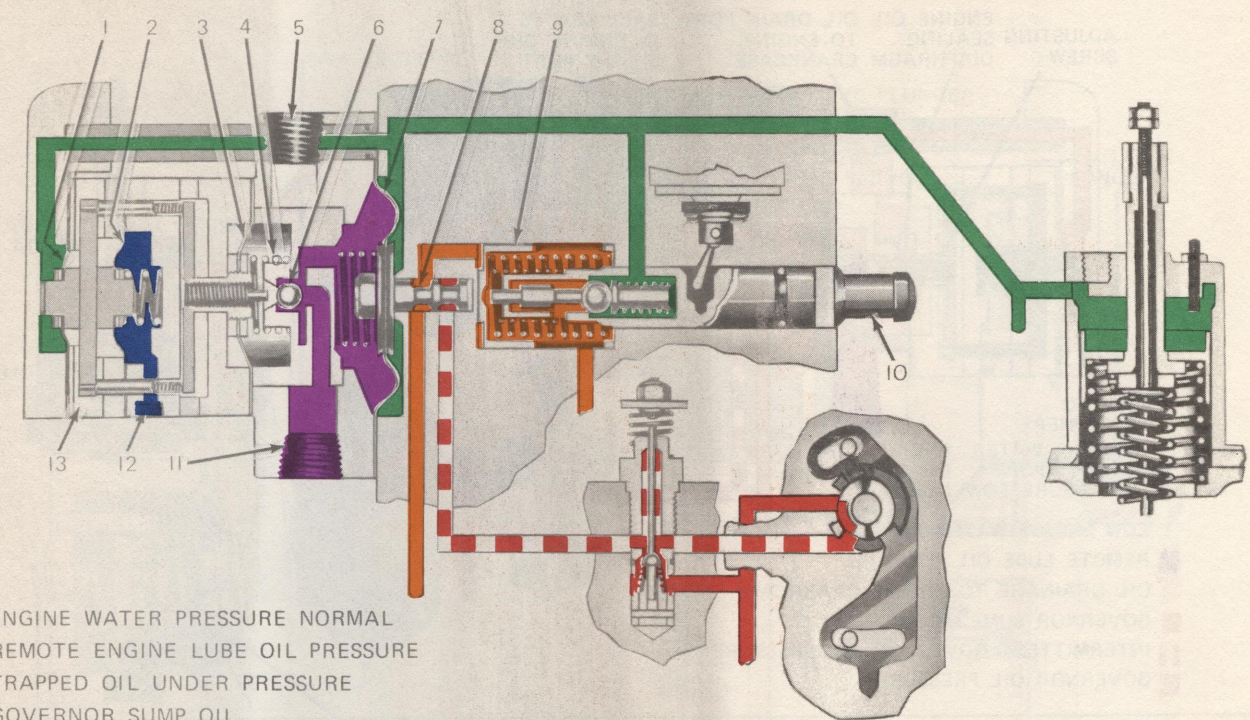
FIG. 16. AUTOMATIC SAFETY SHUTDOWN WITH ENGINE OIL AND WATER PRESSURE PROTECTION. OPERATION OF ANTI-BLOCKING VALVE.

The engine oil sealing diaphragm isolates the engine oil from the water shutdown portion of the device. It carries the adjustable screw which moves the ball valve off its seat in the oil drain port whenever the water pressure diaphragm functions to effect an emergency engine shutdown. Under normal operating conditions as shown in Fig. 17, the oil pressure failure diaphragm and the shutdown valve plunger are positioned towards the shutdown plunger by the diaphragm spring and the engine oil pressure applied to the left side of the diaphragm. The water pressure failure diaphragm and speed setting cylinder diaphragm are held in their extreme left hand position, against oil pressure from the speed setting cylinder, by the water diaphragm spring and water pressure from the engine cooling system.

Engine lubricating oil is prevented from entering the drain cavity surrounding the adjustable screw by the ball valve. This is held against its seat in the drain port by pressure of the engine oil.

Should the pressure of engine cooling water drop below a safe operating value for the particular engine speed setting, an emergency engine shutdown will occur. As shown in Fig. 18, a reduction of pressure on the water pressure failure diaphragm will allow pressure of the trapped oil from the speed setting cylinder to move the speed setting oil diaphragm, and the water pressure failure diaphragm to the right. Thus, through movement of the diaphragm carrier and the adjustable screw, the ball will be moved off its seat in the drain port and against its seat in the oil supply port. This, in turn, will close-off the diaphragm pressure oil supplied by the engine and permit oil in the diaphragm cavity to flow through the drain port to the engine crankcase. Thus the oil pressure on the diaphragm will be

FIG. 17, E-11804



🟦 ENGINE WATER PRESSURE NORMAL
🟪 REMOTE ENGINE LUBE OIL PRESSURE
🟩 TRAPPED OIL UNDER PRESSURE
🟧 GOVERNOR SUMP OIL
🟥 GOVERNOR OIL PRESSURE
▥ INTERMITTENT GOVERNOR OIL PRESSURE

REF.	DESCRIPTION
1	SPEED SETTING OIL DIAPHRAGM
2	WATER PRESSURE FAILURE DIAPHRAGM
3	ENGINE OIL SEALING DIAPHRAGM
4	SEALING DIAPHRAGM SPRING
5	OIL DRAIN PORT TO ENGINE CRANKCASE
6	BALL ON DRAIN SEAT
7	OIL PRESSURE FAILURE DIAPHRAGM
8	SHUTDOWN VALVE PLUNGER
9	SHUTDOWN PISTON
10	SHUTDOWN PLUNGER
11	ENGINE LUBE OIL SUPPLY PORT (PRESSURE NORMAL)
12	ENGINE WATER SUPPLY PORT (PRESSURE NORMAL)
13	VENT TO ATMOSPHERE

FIG. 17. AUTOMATIC SAFETY SHUTDOWN WITH ENGINE OIL AND WATER PRESSURE PROTECTION. NORMAL OPERATING CONDITION.

reduced and effect an emergency engine shutdown in the same manner as would result from an engine oil pressure failure.

The characteristics of this system are the same as those previously described for the low oil pressure shutdown. That is, shutdown will occur at lower engine speeds with a lower water pressure than at higher engine speeds and with the same time delay at IDLE and 1st notch speed as that applying to the low oil pressure shutdown.

Independent Water Shutdown Plunger

A low water pressure shutdown device, independent from the low oil pressure shutdown device, has been applied to the governor to provide identification of the system at fault when a low pressure shutdown occurs.

The low water pressure shutdown device is mounted on the back of the governor, as shown in Fig. 2, and has its own shutdown plunger. (See Fig. 1.) The electric toggle switch in this device is connected to Pin 12 in the governor electric connector.

Adjustments

The water shutdown device is arranged with two pressure adjustments; a differential pressure adjustment which changes the difference between the high and low pressure trip settings and a range adjustment screw which will simultaneously raise or lower both trip pressures.

Consult the GOVERNOR DATA SHEET for setting values and make adjustments as follows (see Fig. 19).

1. Check the trip pressures at both full speed and 2nd notch. To lower both trip pressures, turn the pressure range adjustment screw counterclockwise. To raise trip pressure, turn the screw clockwise. One-half turn on the screw equals about one-half pound of water pressure.

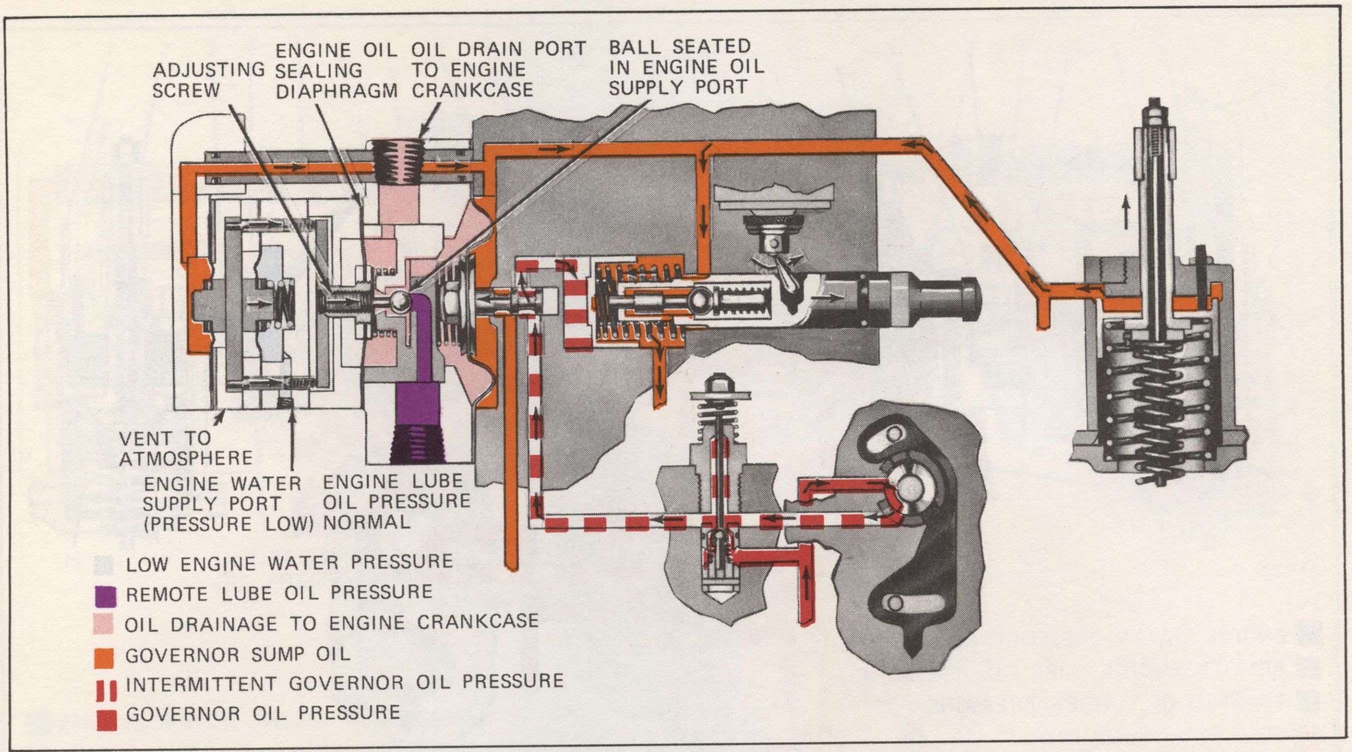

ADJUSTING SCREW
ENGINE OIL SEALING DIAPHRAGM
OIL DRAIN PORT TO ENGINE CRANKCASE
BALL SEATED IN ENGINE OIL SUPPLY PORT
VENT TO ATMOSPHERE
ENGINE WATER SUPPLY PORT (PRESSURE LOW)
ENGINE LUBE OIL PRESSURE NORMAL
LOW ENGINE WATER PRESSURE
REMOTE LUBE OIL PRESSURE
OIL DRAINAGE TO ENGINE CRANKCASE
GOVERNOR SUMP OIL
INTERMITTENT GOVERNOR OIL PRESSURE
GOVERNOR OIL PRESSURE

FIG. 18, E-11805

FIG. 18. AUTOMATIC SAFETY SHUTDOWN WITH ENGINE OIL AND WATER PRESSURE PROTECTION. ACTUATED TO CAUSE SHUTDOWN.

2. To increase the trip pressure at full speed, loosen the two adjustment clamp bolts above the range adjustment screw and raise the diaphragm block slightly. To decrease the trip pressure, lower the diaphragm block. Recheck trip settings. Continue making adjustments in small increments until the proper settings are obtained. Changes to the differential setting will require readjustment of the range setting screw in Step 1.

If the water diaphragm block has been removed, as a reference setting when reassembling it, position the block flush with the top edge of the main body base. In this position, the DIFFERENTIAL PRESSURE ADJUSTMENT REFERENCE is approximately zero. (See Fig. 19.)

LOW OIL AND LOW WATER SHUTDOWN TESTS

The following instruction furnishes information on how to check and adjust the low oil and low water shutdown devices on governors on board the locomotive.

Even though these instructions are designed for testing aboard the locomotive, they can be adapted for testing on a test stand by using the valves and gages on the stand.

Low Oil Shutdown Test

For checking the low oil pressure shutdown device, proceed as follows:

1. Install a test shut-off valve, a suitable pressure gage and a pressure bleed-valve in the engine oil pressure line, where it connects to the safety shutdown device on the governor (Test Point B, Fig. 2). The pressure bleed valve and gage must be connected in the line between the shutoff valve and the governor with one side of the bleed valve open to atmosphere. See Fig. 19A.
2. Open the test shutoff valve and close the bleed valve.
3. Start the engine and allow it to operate at IDLE speed until normal operating temperature has been reached. Then close the test shutoff valve and slowly open the bleed valve to reduce the pressure on the oil pressure diaphragm. Note that when the trip pressure specified for IDLE speed has been reached (see GOVERNOR DATA section), the shutdown plunger begins to move out slowly, indicating the shutdown time delay is in effect. Note also the time required for the plunger to move out to the point where the power piston suddenly moves to the SHUTDOWN position (see GOVERNOR DATA section for specified time delay).
4. Close the bleed valve and open the shutoff valve. Re-start engine.
5. With the locomotive air brakes applied, position the Reverse handle to NEUTRAL, the Selector handle to POSITION NO. 1 (or the Braking handle to OFF), and the Throttle handle to the 8TH NOTCH. Close the test shutoff valve and slowly open the bleed valve. Note that when the trip pressure (see GOVERNOR DATA section for specified value) is reached, the

FIG. 19, E-13403

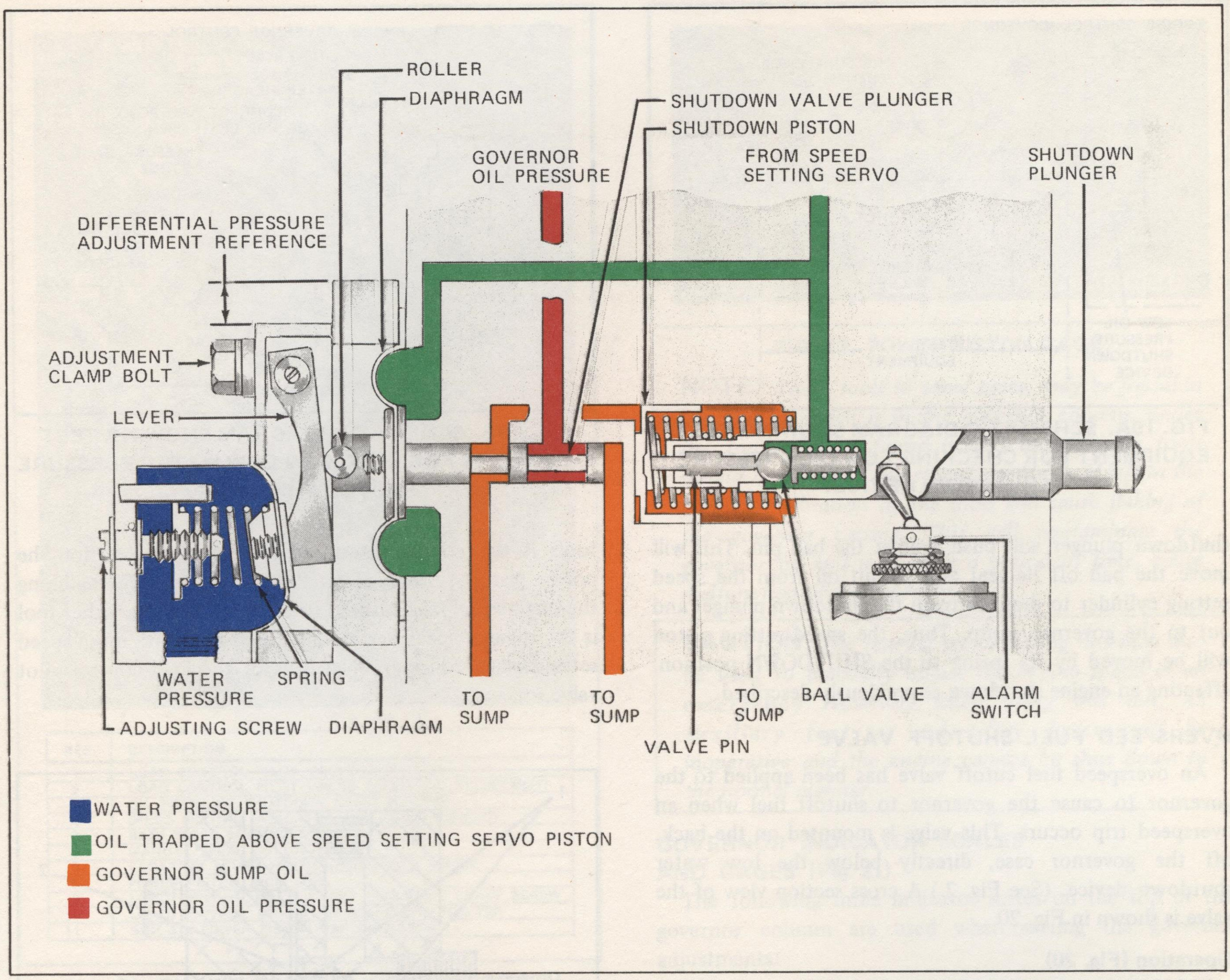

ROLLER
DIAPHRAGM
SHUTDOWN VALVE PLUNGER
SHUTDOWN PISTON
GOVERNOR OIL PRESSURE
FROM SPEED SETTING SERVO
SHUTDOWN PLUNGER
DIFFERENTIAL PRESSURE ADJUSTMENT REFERENCE
ADJUSTMENT CLAMP BOLT
LEVER
WATER PRESSURE
SPRING
ADJUSTING SCREW
DIAPHRAGM
TO SUMP
TO SUMP
TO SUMP
BALL VALVE
ALARM SWITCH
VALVE PIN
🟦 WATER PRESSURE
🟩 OIL TRAPPED ABOVE SPEED SETTING SERVO PISTON
🟧 GOVERNOR SUMP OIL
🟥 GOVERNOR OIL PRESSURE

FIG. 19. INDEPENDENT COOLING SYSTEM FAILURE SHUTDOWN DEVICE (NORMAL OPERATING CONDITION).

shutdown plunger quickly pops out and the engine shuts down. After shutdown, close the bleed valve and re-open the shutoff valve.

NOTE: *The pressure at which the shutdown plunger operates is not subject to adjustment except by changing a spring.*

Alternatively, the oil pressure may be dropped to a value just above the upper shutdown limit specified in the GOVERNOR DATA section and held there for 60 seconds. Engine should not shut down. Repeat at the lower limit and engine should shut down immediately, unless the bypass screw has been removed from the triangular plate. If screw has been removed, shutdown will be delayed about 40 seconds.

Low Water Shutdown Test

The low water shutdown can be tested by following Steps 1 thru 5 above, with the following exceptions:

1. Install a shutoff valve, pressure gage and bleed valve in the water pressure line from the inlet water header, Ref. Test Point "F", Fig. 2. If the governor has a second pressure line to the shutdown device, this line must be disconnected and plugged or capped at each side of the break. See Fig. 19B.
2. If the low water shutdown device is out of adjustment, it can be adjusted by following the adjustment instructions on Page 19. Refer to GOVERNOR DATA section for shutdown pressures.

ANTI-BLOCKING VALVE

Manually "blocking" the operation of the safety shutdown mechanism is prevented by a spring-loaded ball valve inside the shutdown plunger. (See Fig. 16.) This ball valve is normally held on its seat and has no effect on the operation of the shutdown mechanism. However, if an attempt is made to run the engine with insufficient pressures in the engine systems by holding the plunger in, the action of the shutdown piston moving against the

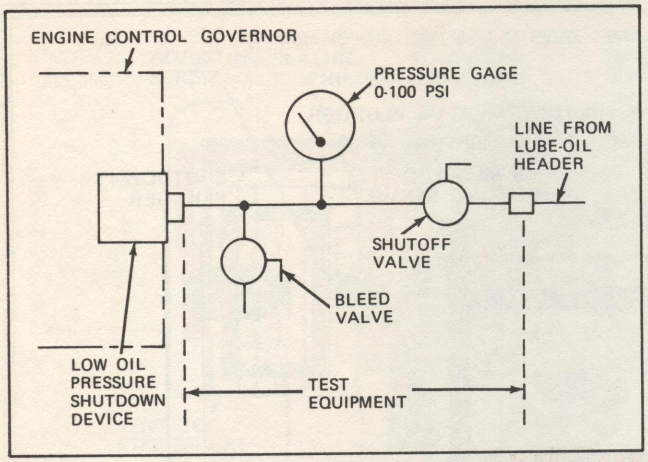

ENGINE CONTROL GOVERNOR
PRESSURE GAGE 0-100 PSI
LINE FROM LUBE-OIL HEADER
SHUTOFF VALVE
BLEED VALVE
LOW OIL PRESSURE SHUTDOWN DEVICE
TEST EQUIPMENT

FIG. 19A. SCHEMATIC DIAGRAM SHOWING TEST EQUIPMENT FOR CHECKING LOW OIL PRESSURE SHUTDOWN DEVICE.

FIG. 19A, E-21435

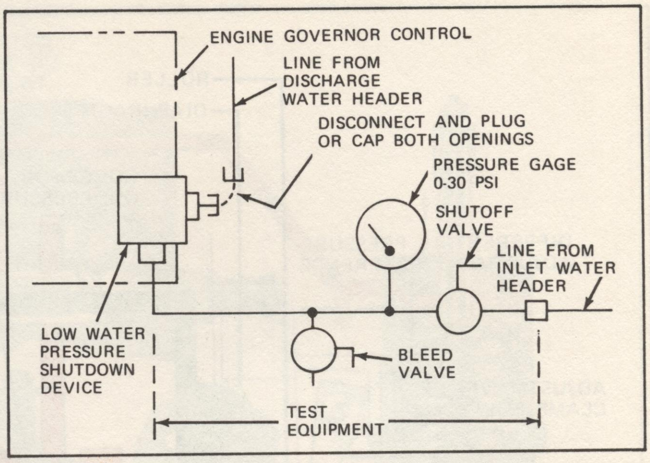

ENGINE GOVERNOR CONTROL
LINE FROM DISCHARGE WATER HEADER
DISCONNECT AND PLUG OR CAP BOTH OPENINGS
PRESSURE GAGE 0-30 PSI
SHUTOFF VALVE
LINE FROM INLET WATER HEADER
LOW WATER PRESSURE SHUTDOWN DEVICE
BLEED VALVE
TEST EQUIPMENT

FIG. 19B. SCHEMATIC DIAGRAM SHOWING TEST EQUIPMENT FOR CHECKING LOW WATER PRESSURE SHUTDOWN DEVICE.

FIG. 19B, E-21436

shutdown plunger will push against the ball pin. This will move the ball off its seat and permit oil from the speed setting cylinder to drain through the shutdown plunger and out to the governor sump. Thus, the speed setting piston will be moved by its spring to the SHUTDOWN position, effecting an engine shutdown as previously described.

OVERSPEED FUEL SHUTOFF VALVE

An overspeed fuel cutoff valve has been applied to the governor to cause the governor to shutoff fuel when an overspeed trip occurs. This valve is mounted on the back, off the governor case, directly below the low water shutdown device. (See Fig. 2.) A cross section view of the valve is shown in Fig. 20.

Operation (Fig. 20)

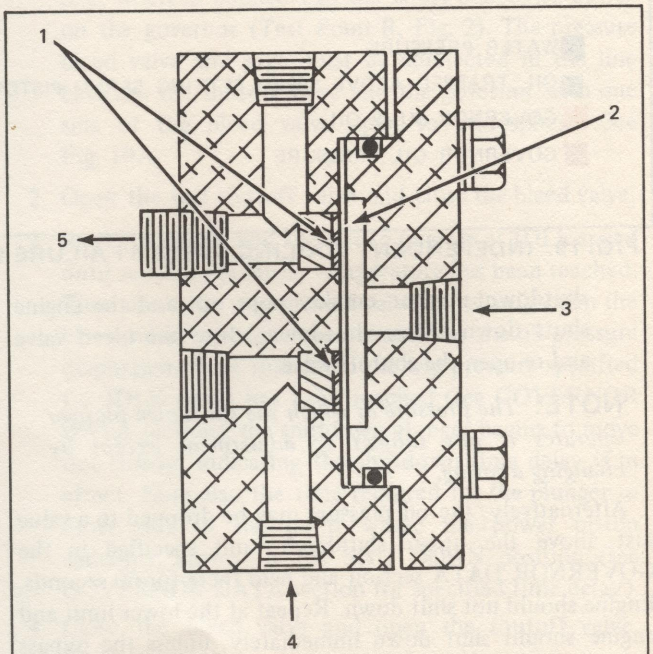
Oil pressure from the engine overspeed system is piped to the single opening at the right side of the valve. This seals the diaphragm over the two screened ports which are connected between the speed setting servo and the governor oil sump.

When the overspeed governor is tripped, the oil pressure is removed from the right side of the diaphragm, thus permitting the oil from the speed setting servo to drain off to the governor oil sump. This dumping of the servo oil to the sump causes the governor to go to a shutdown condition and cuts off fuel to the engine.

GENERAL MAINTENANCE AND ADJUSTMENTS TO GOVERNOR ON THE ENGINE

GOVERNOR TOOLS (Fig. 21)

With some older governors, two special tools were supplied for use in adjusting the governor. One of these tools is the power piston rod jack, used to position the power piston at the correct "piston gap" when matching the engine fuel rack settings to the governor. The other tool is the manual speed setting nut, used to position the speed setting piston during adjustment of the load control pilot valve.

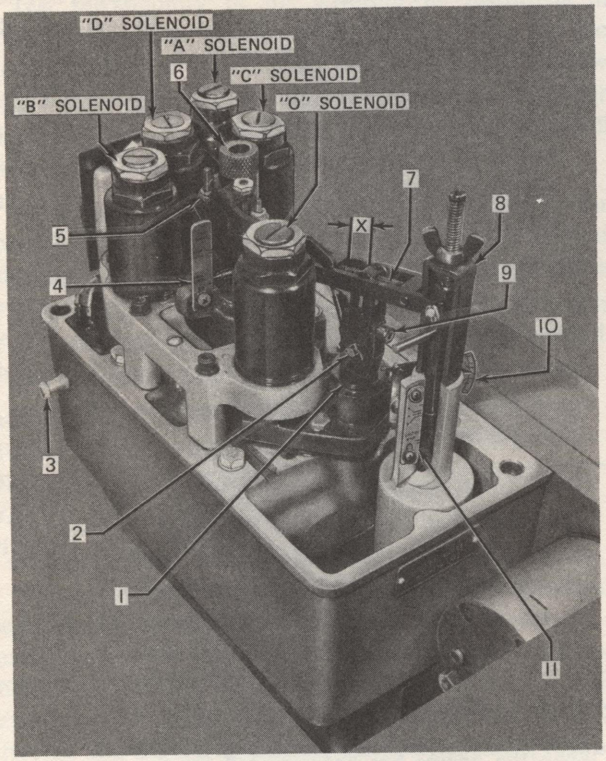


REF.	DESCRIPTION
1	SCREEN INSERTS
2	DIAPHRAGM
3	OIL PRESSURE INPUT FROM OVERSPEED SYSTEM
4	OIL PRESSURE INPUT FROM GOVERNOR SPEED SETTING SERVO
5	OIL DRAIN TO GOVERNOR SUMP

FIG. 20. CUTAWAY VIEW OF OVERSPEED FUEL SHUTOFF VALVE.

FIG. 20, E-13033

FIG. 21, E-9998



REF.	DESCRIPTION
1	LOAD CONTROL PILOT VALVE UMBRELLA
2	LOAD CONTROL PILOT VALVE ECCENTRIC ADJUSTMENT
3	OIL PRESSURE SHUTDOWN RESET BUTTON
4	SPEED SETTING INDICATOR SCALE AND POINTER
5	BASE SPEED SETTING NUT
6	MANUAL SPEED SETTING TOOL
7	FLOATING LEVER RATIO ADJUSTMENT SCREW
8	POWER PISTON JACK TOOL
9	LOAD CONTROL PILOT VALVE ECCENTRIC CLAMP SCREW
10	LOAD CONTROL INDICATOR SCALE AND POINTER
11	BUILT-IN POWER PISTON GAP INDICATOR

FIG. 21. ENGINE CONTROL GOVERNOR WITH ADJUSTING TOOLS IN PLACE.

FIG. 22, E-10008B

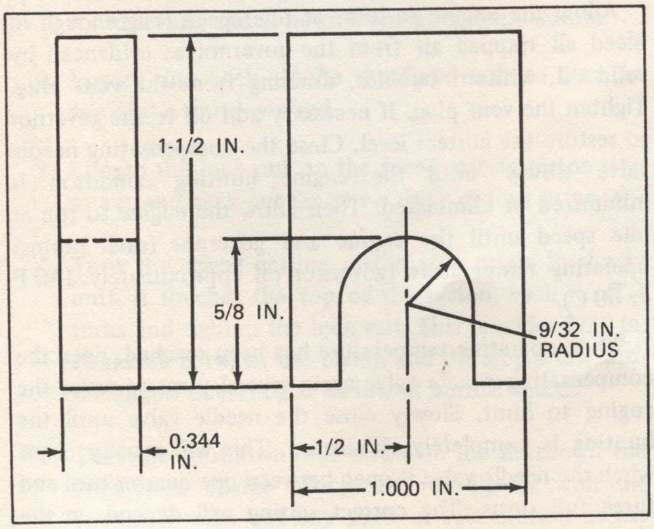


FIG. 22. POWER PISTON GAP GAGE.

FIG. 23, E-8617B

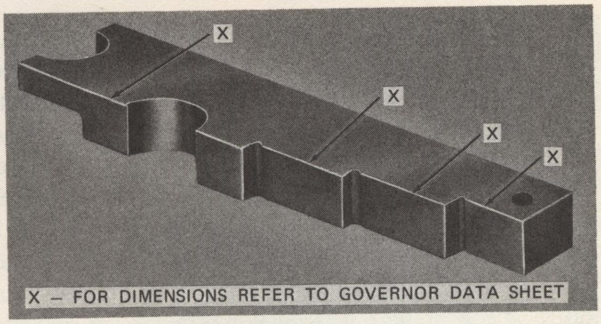


FIG. 23. POWER PISTON GAGE.

NOTE: *These tools in some cases, may be found in the pocket which is in the governor column, under the top cover. If found in this location the tools should be removed and stored elsewhere. If left in the governor, vibration of the tools will cause flaking of the governor casting. This will contaminate the governor oil and may, over a period of time, cause malfunction of the governor.*

CAUTION: *The manual speed setting nut may also be used to manually adjust the engine speed in an emergency. However, when using this nut, all auxiliary features and safety devices will be inoperative and the engine cannot be shut down in the normal manner.*

GOVERNOR INDICATOR SCALES AND GAGES (Fig. 21)

The following three indicator scales on the top of the governor column are used when setting the governor adjustments:

1. The speed indicator scale and pointer, beside the speed setting piston rod.
2. The power piston gap indicator scale (if used) at the top of the power spring housing with its indicating mark on the power piston tail rod.
3. The load control pilot valve plunger indicator near the load control pilot valve.

In some applications two external indicators will be found on the governor cover, one indicating increments of engine speed, while the other indicates increments of power piston gap.

A governor power piston gap gage should be used to accurately position the governor power piston when setting the governor adjustments. This gage is available through the engine tool catalog or, if desired, may be made. The gage shown in Fig. 22 is used for adjusting non-altitude compensating governors on model 7FDL-16 engines. The gage shown in Fig. 23 is used with various governors (altitude and non-altitude compensating governors) used on model 7FDL-8 and 7FDL-12 engines.

GOVERNOR OIL

The type and weight of oil to be used in the governor should agree with that given in the FUEL AND LUBRICANT SPECIFICATIONS for the particular locomotive application. In most cases SAE 10W-30, Grade MS lubricating oil is recommended for ordinary conditions of temperature. If conditions of operation are extremely hot, it may be desirable to use SAE 40 or 50 weight oil. In any case, the oil must not contain additives which are used to free up rings, remove carbon, etc., unless a non-foaming additive is also present. The oil should not foam or sludge when agitated, or form gummy deposits when heated.

CAUTION: *Most governor troubles are caused by dirty oil. Therefore, always use clean, new or well filtered oil. Never mix oils which are incompatible. All containers used for handling oil must be clean and should be rinsed using light grade fuel oil or kerosene before using.*

Oil Level

The governor oil must be maintained at the correct level for reliable operation. The correct oil level is observed with the engine running at IDLE speed. On older governors the correct level is between the two lines on the sight glass; on newer governors the correct level is at the one line on the sight glass. Oil should be added slowly through the filler cap in the top cover. Oil level, if above or below the lines in the gage, when running, will cause aeration of the oil resulting in a hunting condition.

Changing Oil and Flushing Governor

Governor oil should be changed at intervals according to recommendations given in the locomotive LUBRICATION AND SERVICING instruction.

To change the governor oil proceed as follows:

1. With the engine stopped, open the oil drain cocks on the side of the governor case and on the under side of the load control potentiometer housing. Apply a container to catch the used oil.
2. Close the drain cocks and fill the governor with clean, new oil through the filler cap.
3. Start the engine and allow it to operate at IDLE speed. Cause the load control vane servomotor to move through its full travel several times by removing and reconnecting the governor electrical connector. More oil must be slowly added to the governor until the load control potentiometer housing has become full and the oil level remains between the lines in the oil gage.
4. After refilling the governor with oil, trapped air must be bled from the governor oil system. See Compensation Adjustment section.
5. If it is desired to flush the governor system after filling the governor as described above, operate the engine at IDLE speed until the oil becomes warm and completely circulated. Then shut down the engine and repeat Steps 1, 2, 3 and 4 using clean new oil.

NOTE: *Flushing the governor with materials such as fuel oil or kerosene is not recommended because with the governor mounted on the engine this material cannot be completely drained, and therefore will cause dilution of the governor oil and contamination of the governor valves with dirt.*

CAUTION: *When changing governor oil, it is important that the governor be surged enough to completely fill the load control potentiometer housing before applying power to the load control circuit. This is required because the oil serves to dissipate heat generated in the resistor element.*

COMPENSATION ADJUSTMENT

When the engine has been started for the first time, or after the governor oil has been changed the governor oil system must be purged of trapped air.

To purge the system, loosen either of the vent plugs on opposite sides of the governor power case just far enough to establish a leak. (See Fig. 1.) (These plugs are identified by instruction plates.) Start the engine and allow it to operate at IDLE speed. Open the compensating needle valve five turns to cause the engine and governor to hunt. Thus the alternating movements of the governor parts will force all trapped air from the governor oil passages and out through the vent plug.

Allow the engine to hunt at idle speed long enough to bleed all trapped air from the governor as evidenced by solid oil, without bubbles, draining from the vent plug. Tighten the vent plug. If necessary add oil to the governor to restore the correct level. Close the compensating needle valve slowly until the engine hunting condition is minimized or eliminated. Then allow the engine to run at idle speed until the engine and governor reach normal operating temperature (governor oil approximately 140 F or 60 C).

When operating temperature has been reached, open the compensating needle valve again several turns to cause the engine to hunt. Slowly close the needle valve until the hunting is completely eliminated. This will usually occur when the needle valve is open between one-quarter turn and three full turns. The correct setting will depend on the characteristics of the particular engine.

FIG. 24, E-9997

Test the stability of the governor by disturbing the engine speed. Move the throttle to a higher notch and back to IDLE or press down lightly on the governor shutdown rod. If the engine returns to a steady speed the adjustment is satisfactory. If it continues hunting, close the needle valve slightly and test again.

Keep the needle valve as far open as possible to prevent sluggishness and still obtain stability. Once it is correctly adjusted for the engine, no further adjustment should be required except at time of oil change or if a large permanent temperature change takes place, affecting the viscosity of the governor oil.

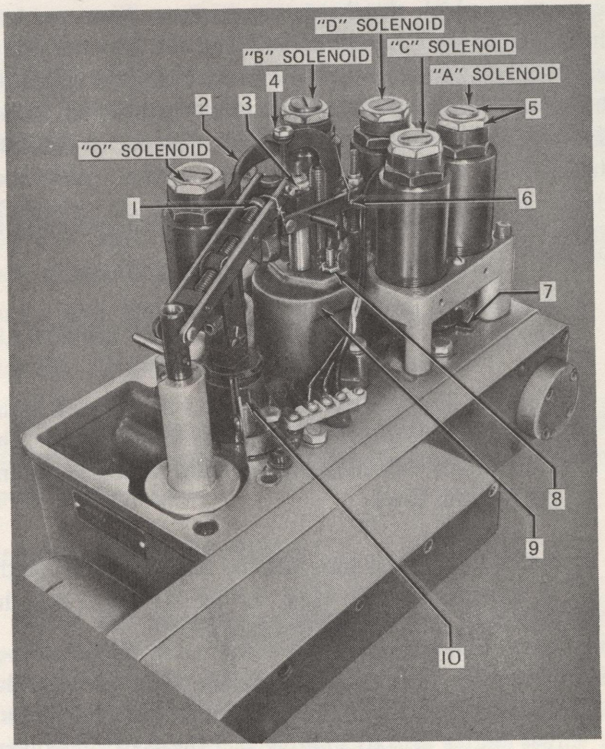
ADJUSTMENT OF THE SHUTDOWN NUTS, START FUEL LIMITING DEVICE, OIL PRESSURE BYPASS VALVE AND SPEED SETTING PISTON STOP SCREW

While all governor adjustments are important and should be made by experienced servicemen, special reference is made here to the adjustment of the shutdown nuts, start fuel limiting device, oil pressure bypass valve and the speed setting piston stop screw. These adjustments will be affected and should be checked whenever engine speeds are readjusted. Premature shutdown, failure to shutdown, or even failure to operate at all can result if these adjustments are improperly set.

ADJUSTMENT OF SHUTDOWN NUTS AND SPEED SETTING PISTON STOP ON GOVERNORS NOT EQUIPPED WITH START FUEL LIMITING DEVICE

The shutdown nuts will be found at the top of the shutdown rod projecting out of the top of the speed setting cylinder. See Fig. 21 and 24.

1. Operate the engine at IDLE or at its lowest normal speed setting and at normal operating temperature.
2. Loosen and back-off the shutdown nuts to near the top of the shutdown rod.
3. Loosen the lock nut on the speed setting piston stop screw, and back-out the screw three or four turns.
4. Turn the speed setting piston stop screw in slowly until it touches the top of the piston, back it off 3 turns and tighten the lock nut. This provides 3/32 in. clearance between the piston and the stop screw with the engine operating at its lowest normal speed.
5. Turn the shutdown nuts down on the shutdown rod enough to enable lifting the rod lightly with the fingers to take out any slack or lost motion at the inner end of the rod.



REF.	DESCRIPTION
1	FLOATING LEVER RATIO ADJUSTMENT SCREW
2	START FUEL LIMITING DEVICE CONTROL LEVER
3	SHUTDOWN ROD AND NUTS
4	ADJUSTABLE LIFT SCREW AND LOCK NUT FOR START FUEL LIMITING DEVICE
5	ADJUSTING SCREW AND LOCKNUT FOR SOLENOID
6	PIN AND LOCK SPRING CLIP FOR START FUEL LIMITING DEVICE
7	OIL PRESSURE SHUTDOWN TIME DELAY ADJUSTMENT
8	SPEED SETTING PISTON STOP SCREW AND LOCKNUT
9	SPEED SETTING SERVO ASSEMBLY
10	LOAD CONTROL PILOT VALVE ASSEMBLY

FIG. 24. ENGINE CONTROL GOVERNOR — TOP RIGHT SIDE WITH COVER REMOVED.

6. With the slack out, adjust the lower shutdown nut to 1/16 in. clearance over the top of the piston rod, and lock it into position with the upper nut.

ADJUSTMENT OF SHUTDOWN NUTS AND SPEED SETTING STOP SCREW ON GOVERNORS EQUIPPED WITH START FUEL LIMITING DEVICE (Figs. 21 and 24)

The start fuel limiting device consists of a control lever positioned directly above the speed setting cylinder with one end pivoted at the upper end of the restoring link.

The other end, at idle speed, will contact the floating beam between the speed setting piston and the power piston tail rod to limit fuel.

Near the center of the control lever is an adjustment screw upon which the shutdown nut rests. When cranking the engine to start, the device will limit the governor power piston opening and thus the fuel to the engine by lifting the shutdown rod. The device, when properly adjusted, has no affect on the governor operation after the engine has been started.

To adjust the start fuel limiting device, proceed as follows:

1. Operate the governor at idle speed and with a 1 in. piston gap.
2. The fuel limit control lever should be adjusted so the end should be above (clear of) the floating beam. The head of the adjusting screw should be seated against the fulcrum block.
3. Set the shutdown gap. Lift the shutdown rod lightly to remove all slack when setting the gap. Lock the shutdown nut with the locknut above it.
4. Raise the power piston to the value given in the GOVERNOR DATA instruction. Adjust the starting fuel limiter to start limiting fuel (head of adjustment screw begins to lift shutdown nuts) when the power piston gap reaches the GOVERNOR DATA value.

If the above adjustments are correct, when starting the engine, the fuel racks should open to a maximum of 12 to 14 mm.

ADJUSTMENT OF THE OIL PRESSURE BYPASS VALVE

With the engine speed correctly set the bypass valve adjustment screw in the triangular plate must be set so that when the pressure is removed from the engine oil pressure diaphragm, the governor shuts down the engine after a time delay at IDLE and 1st notch speeds while at 2nd notch speed or above, engine shutdown occurs immediately. To check or adjust the bypass valve, proceed as follows:

1. Install a test shut-off valve, a suitable pressure gage and a pressure bleed-valve in the engine oil pressure line where it connects to the safety shutdown device on the governor. See Fig. 19A and 19B. The pressure bleed valve must be connected in the line between the shutoff valve and the governor with one side of the bleed valve open to atmosphere.
2. Open the test shut-off valve and close the bleed valve.
3. Start the engine and allow it to operate at IDLE speed until normal operating temperature has been reached. Then close the test shut-off valve and slowly open the bleed valve to reduce the pressure on the oil pressure diaphragm. Note that when the trip pressure specified for IDLE speed has been reached, (see GOVERNOR DATA SHEET) the shutdown plunger begins to slowly move out, indicating the shutdown time delay is in effect.
4. Close the bleed valve and open the shut-off valve. Re-start the engine if it was permitted to shut down.
5. With the locomotive air brakes applied, position the Reverse handle to NEUTRAL, the Selector handle to position No. 1 and the Throttle handle to the 2nd notch. Close the test shut-off valve and slowly open the bleed valve. Note that when the trip pressure is reached, the safety shutdown trips immediately, shutting down the engine.
6. If the bypass valve is improperly adjusted, it should be reset as follows:

   Insert a long straight Allen wrench, (supplied in the governor tool kit) through the hole between solenoids C and D and into the No. 10 socket head adjustment screw. Turn the screw two full turns "OUT" (CCW).
7. Close the bleed valve and open the test shutoff valve. Operate the engine in the 2nd notch as described in Step 5 above. Close the test shutoff valve and fully open the bleed valve. While the shutdown mechanism is timing out, quickly turn the adjustment screw in (CW) until the point is reached at which the valve is lifted off its seat, causing immediate engine shutdown. When this point is reached, turn the screw 1/4 turn more and remove the wrench.
8. Re-check the operation of the bypass valve as described in Steps 3 through 5.

ADJUSTING OVERRIDING SOLENOID

1. Operate the engine at IDLE speed and normal operating temperature.
2. De-energize the "O" solenoid by either insulating the locomotive control interlocking which is supplying power to the solenoid coil or by removing the governor electrical connector.
3. Loosen the locking nut on top of the "O" solenoid and turn the adjusting screw plug in slowly (clockwise) until the load control pilot valve plunger rises. Slowly back the adjusting screw off until the pilot valve plunger starts to move down. Back the adjusting screw off 1/4 turn more and tighten the lock nut.

4. Check the operation of the "O" solenoid by energizing and de-energizing it. Upon energizing the solenoid, the pilot valve plunger should quickly rise to its full upward travel. Upon de-energizing the solenoid the pilot valve plunger should move down at a somewhat slower rate than its upward movement.

ADJUSTMENT OF THE SAFETY SHUTDOWN SWITCH

The safety shutdown switch, mounted over the shutdown plunger at the rear of the solenoid bracket, is arranged with slotted screw holes in its mounting bracket which permits positioning the switch toggle and shutdown plunger to obtain positive tripping action of the shutdown mechanism. If the switch is positioned too far toward the inner end of the shutdown plunger, premature engine shutdown will occur. If positioned too far toward the outer end of the shutdown plunger, the engine will not shut down on low oil pressure at idle speed but will develop a condition of speed surging.

The position of the switch is correct when, upon lightly depressing the shutdown plunger, 1/64 in. free movement is obtained before the anti-blocking valve pin strikes the shutdown piston.

CHECKING VANE SERVOMOTOR TIMING

(See DATA Governor Sheet For Specified Timing)

1. Operate the engine at idle until normal operating temperature (approximately 140 F or 60 C on governor oil) is reached.

2. De-energize the overriding solenoid to allow the vane servomotor and potentiometer brush arm to move to its maximum field position. This may be accomplished by insulating the locomotive interlock contact supplying power to the "O" solenoid coil or by removing the electrical connector from the governor.

3. Insert the blade of a medium size screwdriver under the load control pilot valve umbrella. Gently lift the pilot valve. At the same time, using a stop watch, check the time required for the white indicator dot in the load control window to rotate its full travel from maximum field to minimum field position. Do not lift the pilot valve plunger too high or the quick dump action will become effective.

4. Release the pilot valve plunger, checking the time required for the white indicator dot to rotate its full travel from minimum field position to maximum field position.

ADJUSTING ENGINE SPEED-LOAD RELATIONSHIP

In order that the governor may accurately control the engine speed and load, it is important that the proper relationship exists between the governor speed and load controlling mechanisms and the engine fuel racks. Therefore, the following instructions should be closely followed. See GOVERNOR DATA sheet for specific settings according to the governor model number.

MATCHING ENGINE PUMP RACKS TO GOVERNOR

Refer to instructions entitled FUEL PUMP RACK SETTINGS for adjusting procedure and rack values for specific locomotives.

ENGINE SPEED SETTINGS

Before any attempt is made to check or reset engine speeds, the governor piston gap and engine fuel pump racks must be correctly matched as described above. For the following speed checks and adjustments an accurately calibrated tachometer must be attached to the engine to determine crankshaft speed.

CHECKING ENGINE SPEEDS

1. Start the engine and allow it to warm-up to normal operating temperature.

2. With the Throttle handle at IDLE, Reverse handle in NEUTRAL, the Selector handle in Position 1 (or the Braking handle to OFF), check the idle speed of the engine using the tachometer.

3. Advance the Throttle handle, checking speeds at each numbered notch. Speeds should be within limits given on the DATA sheet. If speed readings are out of limits, they should be reset.

ADJUSTING ENGINE SPEEDS

(See DATA Sheet for Correct Engine Speed Schedule)

1. With the Reverse handle in NEUTRAL position and the Selector handle in Position 1 (or the Braking handle in OFF), advance the Throttle handle to the 6th notch which is the base speed setting. Read the engine speed and if necessary, adjust this speed using the base speed setting nut. (See Fig. 21.) Turn the nut counterclockwise to increase speed. (Readjustment of the base speed nut will change all other speeds by an equal amount.)

2. Advance the Throttle handle to the 8th notch and read speed. If necessary, adjust this speed by loosening the locknut on top of solenoid D. Using a screwdriver, turn the adjustable screw-plug to set the speed. On solenoid D, turning the adjustable screw clockwise will increase speed. Tighten the locknut after each trial adjustment.

3. Move the Throttle handle to the 7th notch. Check the speed reading. If necessary, readjust the speed using the adjustable screw plug on top of solenoid A. Secure the locking nut.

4. Move the Throttle handle to the 4th notch. Check the speed reading. If necessary, readjust the speed using the adjustable screw on top of solenoid B. Secure the locking nut.

5. Move the Throttle handle to IDLE. Check the idle speed. If necessary, readjust the speed using the adjustable screw on top of solenoid C. Secure the locking nut.

6. Recheck each speed setting to assure final settings are correct. If the settings are not within the limits given, repeat Steps 1 through 5 above.

NOTE: *When setting the engine speed, if all speeds are found to be high or low by an equal amount, it may only be necessary to adjust the base speed setting nut to raise or lower all speeds.*

Readjustment of the engine speed settings will affect the adjustment of the governor shutdown nuts, the low oil pressure shutdown bypass valve and the speed setting piston stop screw. Therefore, after making any speed adjustments, check the adjustment of the shutdown nuts, speed setting piston stop screw and the bypass valve. See adjustment of these items previously described in this section.

ADJUSTING THE LOAD CONTROL MECHANISM

Although all governor adjustments are important and should be made only by experienced servicemen, it is extremely important that the load control adjustments be properly set as they directly affect the horsepower output of the power plant.

A number of malfunctions of the power plant system will be detected and automatically compensated for by the load control mechanism. This will be indicated by the load control potentiometer brush arm indicator (white dot visible through the load control window) operating near or at its minimum field position while the engine is operating on load. In some instances, this condition may be mistaken as malfunction of the governor. Therefore, before making any adjustments to the governor, investigate the following items:

1. Check to see all cylinders are firing properly.

2. See that the generator excitation system is functioning properly and that the auxiliary governor voltage is correct.

3. Be sure the engine fuel racks are free to move and are properly matched to the governor power piston travel. The fuel racks and linkage must be free to move somewhat beyond their normal full fuel positions to permit proper functioning of the load control mechanism.

To adjust the load control mechanism, proceed as follows:

1. See that engine speeds are correctly set and that the speed indicator scale in the governor is calibrated so that the STOP, IDLE and FULL SPEED scribed lines on the indicator plate coincide with the indicator pointer for each of these speeds. (See Engine Speed Settings section.)

2. Operate the engine at IDLE speed.

3. De-energize the overriding "O" solenoid by disconnecting the electrical connector from the governor. Loosen the locknut on the top of the "O" solenoid and turn the adjusting screw to position the plunger at least 2-1/2 turns off the bottom. This is necessary to assure that the overriding solenoid does not affect the operation of the load control pilot valve while making the following adjustments.

4. With the engine operating at IDLE speed, check the calibration of the load control pilot valve indicator as follows:
   a. Apply the bit of a long screwdriver under the head of the eccentric clamp screw to raise or lower the load control pilot valve. Observe the position of the brush arm indicator (white dot in window). Continue to position the pilot valve until the brush arm indicator remains stationary or barely creeps in either direction when positioned near its mid-point. When this condition is reached, the pilot valve is centered. If properly calibrated, the pilot valve indicator should exactly coincide with the ZERO mark on the indicator scale.

NOTE: *If the load control pilot valve is adjusted for "Minimum Field Start" it will be necessary to loosen the eccentric adjustment clamp screw to permit the pilot valve to be manually centered.*

b. If the indicator is not correctly calibrated, loosen the indicator mounting screw and shift the indicator scale plate up or down to cause the pointer to exactly coincide with the ZERO mark while the pilot valve is centered. Then tighten the mounting screw.

NOTE: *If the indicator scale plate is doweled in position, the indicator should be calibrated as follows:*

Loosen the locknut under the umbrella, on the pilot valve stem using a thin, 1/2 in. open-end wrench. Then thread the valve plunger in or out of the adjusting block to position the pointer exactly on ZERO with the pilot valve centered.

After each adjustment, check the calibration of the pilot valve indicator as described in Step 4-a. When the adjustment is correct, tighten the locknut.

5. Shut down the engine. Block open or insulate the starting contactors to prevent the engine being accidently cranked and started during the following adjustments.

6. Install the manual speed setting tool on the stud provided. (See Fig. 21.) Turn the tool down until the speed indicator pointer exactly coincides with the IDLE mark on the indicator scale.

7. Install the power piston jack tool on the power piston rail rod. (See Fig. 21.) Install the portion of the power piston gap gage to obtain the correct piston gap for idle speed. Refer to the governor DATA sheet. Clamp the gage firmly by turning the wing nut on the tool. To assist in raising the power piston, apply a prying force to the rack linkage near the governor.

8. Loosen the eccentric adjustment clamp screw and adjust the eccentric to position the pilot valve indicator pointer to exactly coincide with either the "Maximum or Minimum Field" start mark on the indicator scale. Refer to the Governor DATA sheet for specified setting.

9. Turn the manual speed setting tool down until the speed indicator pointer exactly coincides with the FULL SPEED mark on the indicator scale.

10. Install the portion of the power piston gap gage to obtain the correct power piston gap for full speed-full load. Refer to the governor DATA sheet. Clamp the gage firmly by tightening the wing nut on the tool. The pilot valve indicator pointer should now exactly coincide with the ZERO mark on the indicator scale.

11. If, in Step 10, the indicator pointer does not coincide with the ZERO mark on the scale, adjust the screw in the floating lever over the load control pilot valve to cause the pointer to move one half the distance toward the ZERO mark. Then adjust the eccentric to bring the pointer the remaining distance and exactly in line with the ZERO mark.

12. Repeat Steps 6 and 7 and observe that the pointer position as set in Step 8 has not changed. Continue adjustments as described in Steps 6 through 11 until the indicator pointer moves to the correct position at both the idle and full speed settings.

13. Remove the governor tools and make sure all adjustments are locked.

CAUTION: *Extensive engine damage can result from over-speeding if the engine is started with the governor tools applied.*

14. Readjust the Overriding Solenoid. See Overriding Solenoid Adjustments section.

CHECKING GOVERNOR WIRING
(Fig. 25 or Fig. 26)

To check the internal wiring of a governor equipped with a 12-pin connector, with the engine shut down, proceed as follows:

1. Disconnect the electrical connector from the governor.

2. Using an ohmmeter, check from Pin 9 to Pins 4, 5, 6, 7 and 8 in turn. See DATA sheet for solenoid resistance values.

3. Connect the ohmmeter from Pin 10 to Pin 11. If the oil safety shutdown plunger is OUT, the ohmmeter should indicate a closed circuit (zero resistance). Push the oil safety shutdown plunger IN. The circuit should read OPEN (infinite resistance). With the ohmmeter connected from Pin 10 to Pin 12, repeat the test moving the water safety shutdown plunger OUT and IN.

4. Using the ohmmeter, check the resistance of the load control potentiometer by measuring between Pins 2 and 3 and from Pins 1 to 2 and 1 to 3. The latter two readings will vary depending on the position of the rheostat brush arm. If, after long service, an unusually high or erratic resistance reading is noted between the rotating brush and the resistor unit, it may be caused by the formation of oxides on the surface of the rheostat commutator and contact brushes. See instructions, CLEANING AND INSPECTION OF GOVERNOR PARTS.

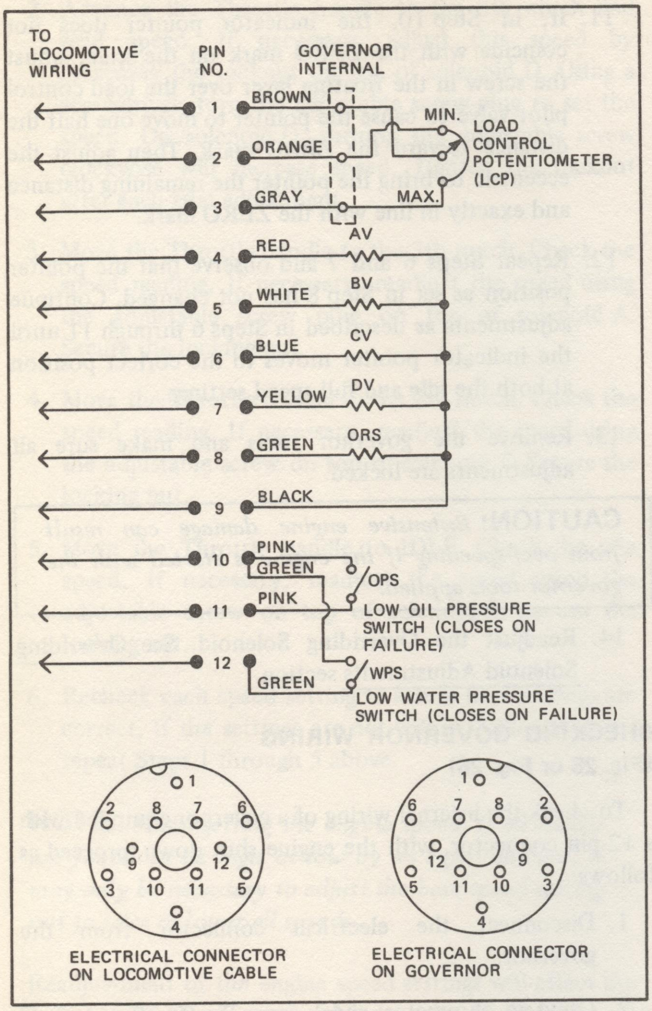

TO LOCOMOTIVE WIRING
PIN NO.
GOVERNOR INTERNAL
1 BROWN
2 ORANGE
3 GRAY
MIN.
MAX.
LOAD CONTROL POTENTIOMETER (LCP)
4 RED
AV
5 WHITE
BV
6 BLUE
CV
7 YELLOW
DV
8 GREEN
ORS
9 BLACK
10 PINK
GREEN
OPS
11 PINK
LOW OIL PRESSURE SWITCH (CLOSES ON FAILURE)
12 GREEN
WPS
LOW WATER PRESSURE SWITCH (CLOSES ON FAILURE)
1 2 8 7 6 9 12 3 10 11 5 4
ELECTRICAL CONNECTOR ON LOCOMOTIVE CABLE
1 6 7 8 2 12 9 5 11 10 3 4
ELECTRICAL CONNECTOR ON GOVERNOR

FIG. 25. PG GOVERNOR WIRING DIAGRAM, 12-PIN CONNECTOR.

FIG. 25, E-9968C

To check recent-production governors equipped with 16-pin connectors, refer to Fig. 26 and perform similar checks as outlined for the 12-pin connector given above.

REMOVING GOVERNOR FROM ENGINE

1. Have the diesel engine stopped and the engine starting contactors blocked open or insulated.
2. Remove the electrical connector plug from the governor.
3. Remove the cotter pin from the power piston clevis and remove the clevis pin to disconnect the fuel rack linkage.
4. Disconnect external piping attached to the governor.
5. Install an eyebolt in the governor top cover and attach a hoist supported from the engine hood. Lift the governor straight up until its splined shaft clears the governor drive gear case. Then lower the governor to the locomotive platform.

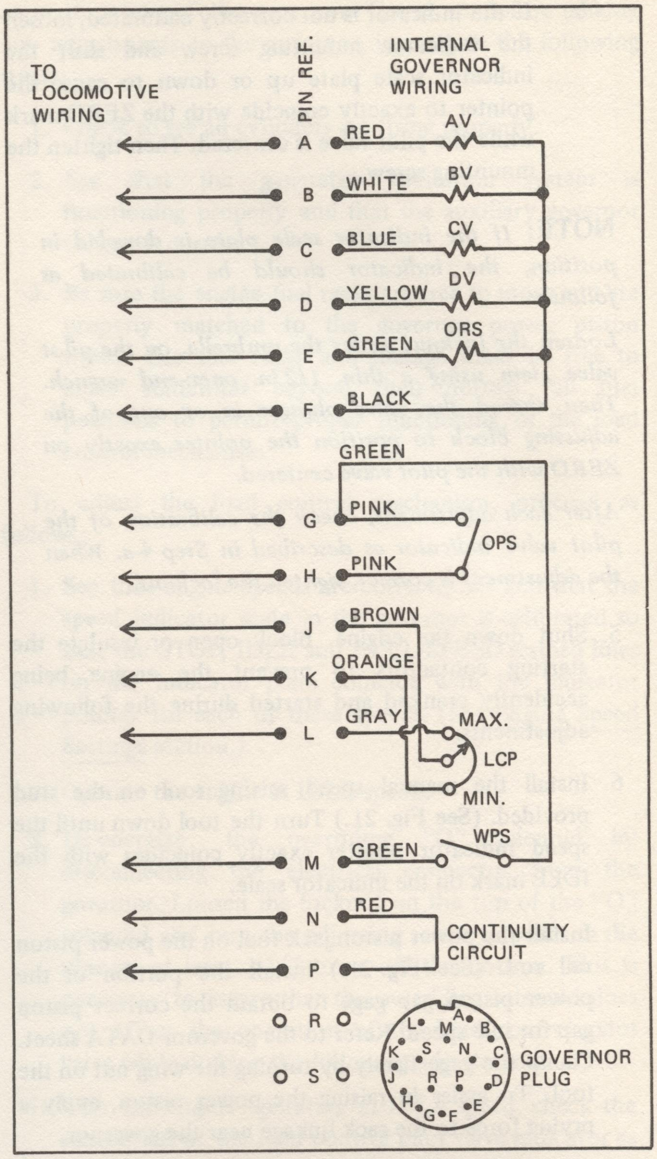

TO LOCOMOTIVE WIRING
PIN REF.
INTERNAL GOVERNOR WIRING
A RED AV
B WHITE BV
C BLUE CV
D YELLOW DV
E GREEN ORS
F BLACK
GREEN
G PINK
OPS
H PINK
J BROWN
K ORANGE
L GRAY
MAX.
LCP
MIN.
WPS
M GREEN
N RED
CONTINUITY CIRCUIT
P
R
S
A B C D E F G H J K L M N P R S
GOVERNOR PLUG

FIG. 26. PG GOVERNOR WIRING DIAGRAM, 16-PIN CONNECTOR.

FIG. 26, E-21471

GOVERNOR INSTALLATION

1. Make sure the governor drive shaft and mounting surfaces are clean. Install a new gasket on the governor mounting surface.
2. Hoist the governor into position over the governor drive housing, aligning the spline drive and lowering the governor into position. No force should be required to properly seat the governor.

3. Assemble the nuts and lockwashers to secure the governor in position. Then reconnect the fuel rack linkage, making sure linkage is properly aligned to prevent binding.

4. Attach the external governor piping and tighten the fittings securely.

5. Check the governor oil level and add oil as required. See Governor Oil section.

6. Match the fuel racks to the governor power piston gap.

7. Attach the electrical connector to the governor. Remove the blocking from the engine starting contactors and prepare to make an operational test of the governor. Review the governor adjustments previously discussed.

FUEL RACK LINKAGE

DESCRIPTION

The fuel rack linkage connecting the governor power piston to the individual cylinder pump racks consists of a series of levers, shafts and push-rods of fixed lengths, which move on oil bronze bushings. An adjustable link at each fuel pump rack is the only adjustment in the linkage system.

MAINTENANCE

Bearings in the fuel rack linkage are equipped with oiler buttons or grease fittings and should be lubricated periodically according to instructions given in the locomotive LUBRICATION AND SERVICING SCHEDULE. The linkage parts should also be inspected periodically for binding and excessive lost motion caused by worn bearings.

NOTE: *When assembling the fuel rack linkage, tighten the elastic stop nuts on all spherical bearings to 20-25 lb.-ft. torque. To overtighten these nuts will distort the bearing, thus causing the linkage to bind.*

RECONDITIONING THE GOVERNOR

The governor should be removed from the engine and reconditioned at time of general engine overhaul. Governor work, to a degree, is special in that the governor is a precision device requiring special tools and test equipment as well as a serviceman who is familiar with its various functional parts. Governor work should be performed in a clean, well lighted room separate from the shop area and reserved for only this type of work. The room should also be supplied with clean, filtered air which is maintained at a fairly constant temperature. For testing and making adjustments to the governor after reconditioning, it is essential that a Woodward governor test stand be available.

GOVERNOR DISASSEMBLY

PREPARATION

Before attempting to disassemble a governor, the following preparation should be made:

1. Completely drain the oil from both governor cavities. This may best be done by placing the governor in an inverted position over an open container. Block the oil fill cap open and fully open both of the drain cocks.

2. Thoroughly clean the outer surfaces of the governor using a bristle brush and diesel fuel or other suitable cleaner. Do not use cleaners which will attack aluminum metal or electric insulation.

3. For best accessibility during governor work, the governor should be mounted on a bench arranged with a drilled hole to accept the governor drive shaft.

4. Construct a basket of fine mesh wire screen to contain parts for cleaning. Prepare a table, covered with clean paper or a partitioned wooden tray to hold the cleaned parts prior to reassembling the governor. After the parts have been cleaned and inspected, place them on the table or in the tray in a neat and orderly manner to allow quick identification during assembly.

Care should be taken to prevent highly finished surfaces of parts from becoming scratched or nicked during work. Parts which are damaged must be renewed.

NOTE: *Parts should never be interchanged between governors during shop work. Therefore, if a number of similar governors are in process of being reconditioned, it is imperative that parts of each governor be properly identified and kept separated from those of other governors.*

DISASSEMBLING GOVERNOR

When disassembling a governor, it is not generally necessary to completely disassemble all parts. Therefore, the following procedure describes only the disassembly and removal of those parts considered essential to properly inspect and recondition the governor.

Various parts of the governor are identified in the following steps by reference numbers which appear on the exploded assembly views shown in Fig. 38, 39, 40, 41, 42. Frequent reference should be made to these figures for construction details not covered in the text.

Cover and Solenoid Pack (Fig. 38)

1. Remove the two cover bolts (1) and lift off the cover.

2. Disconnect the three wires from the load control potentiometer terminal block (541).

3. Remove the three socket head screws (26) and lift off the solenoid pack (94).

Column Assembly (Fig. 38, 39 and 40)

1. Remove the speed setting pilot valve assembly from the column by first removing screw (148), screw (150) and the bushing retainer (154). Also remove the "D" solenoid cup (155), the speed pilot valve pin (156), and the regulating bushing (158).

NOTE: *Use care so as not to permanently distort the leaf springs supporting the triangular plate (105).*

2. Pull out the pilot valve plunger (160) with the thrust bearing assembly (159) and spring (163). Also lift out the pilot valve bushing (161) and spring (162).

3. Disconnect the restoring lever (112) from the adjustable floating lever (174) by removing pin (108) from the pivot pin link (109).

4. Remove the speed setting cylinder assembly with its associated linkage attached by first removing the two shutdown nuts (119) from the top of the shutdown rod. Then remove the mounting screws (127) at each side of the speed setting cylinder. Press downward on the cylinder while removing the screws to hold it in place against its spring pressure. Remove the spring (137) over the bypass valve, the triangular plate (105), and the speed setting piston spring (132). Note and remove the small O-ring found under the speed setting cylinder.

   To remove the speed setting piston from its cylinder, the fulcrum block must be removed from the top of the piston rod. The fulcrum block is pressed onto the piston rod and may be removed using a small puller tool or an arbor press. If an arbor press is used, support the fulcrum block on parallel bars and apply the force against the end of the piston rod.

5. Disconnect the adjustable floating lever from the power piston tail rod by removing pin (173).

6. Remove the overriding valve plunger (187) and spring (188) from the cylinder housing (194). Then remove the two mounting screws (189) and lift the overriding cylinder housing along with the load control pilot valve assembly from the column. Lift out the cylinder head (196), seal (197), gasket (198), spring (201), and the pilot valve bushing (202).

7. Disassemble the load control pilot valve plunger and overriding piston from the overriding cylinder housing by first loosening locknut (180) and threading the adjustment block (178) off the pilot valve stem. Then remove the snap ring (181), retainer (182), spring (183), locknut and spring collar (180, 185) and piston (186).

8. Remove the bypass valve body (142) containing the valve assembly.

Load Control Potentiometer Assembly (Fig. 40 and 42)

1. Remove the cover (530) from the load control potentiometer by removing screws (522 and 523).

2. Remove the rheostat indicator disk (535) by prying open the bent tab on the lockwasher (533) and removing the indicator locknut (532). Pull the disk straight out and off its shaft.

3. Remove the load control potentiometer assembly (556) by removing the three potentiometer wires from the terminal board (541) and the two socket head screws (551), located in the outer end of the rheostat commutator. Also remove the two mounting screws (545) each with two insulating washers (546) from the resistor pack and carefully lift the pack and commutator off, carefully pulling the lead wires out of the column.

4. Remove the servomotor by removing the two nuts (501) from their stud screws and sliding the servomotor off the studs.

5. The vane servomotor may be disassembled by removing socket head screws (515) and pulling outward on the back plate (516).

NOTE: *If the vane is removed, care must be taken not to damage the seal inserts and load springs in the vane and shaft.*

6. Remove the load control potentiometer side plate (563 or 230) by removing socket head screws (561). Note and remove oil supply valve plunger (565), spring (566), and sleeve (567).

Safety Shutdown Device (Fig. 40)

1. Remove the shutdown plunger by pulling it outward from the column. Then remove the diaphragm assemble (221), screw (232), bushing assembly (234), gasket (235), piston (236) and spring (237).

NOTE: *If the safety shutdown device is equipped with both oil and water pressure failure mechanisms, it may be disassembled using the exploded assembly view in Fig. 40.*

Load Control Adjustable Ball Valves (Fig. 42)

1. To remove valves, remove screw (568), instruction plate (569) and retainer (570). Remove the adjustment screws and insert a longer screw which can be grasped to pull out the valves.
2. If necessary, the valves may be disassembled by removing the snap ring (573) and the adjustment screw (571).

NOTE: *Governors on which the vane servomotor timing is fixed have the valve openings in column plugged. To remove these plugs, remove the retainer plate and pull the plugs using a screw threaded into the plug.*

Removing Column (Fig. 40)

1. To remove the column from the power case, remove the four cap screws (253) and lift off the column.
2. Remove the pinion gear (164) which drives the speed pilot valve bushings.

This completes the disassembly of the governor column.

Flyweight Head and Rotating Sleeve Assembly (Fig. 41)

1. Lift the flyweight head and rotating sleeve assembly from the power case.
2. Lift off the speeder spring (268).
3. Remove the cotter pin (269) and back off the pilot plunger nut (270). Then lift off the speeder spring seat (273), thrust bearing (274), washer (275), and adjusting springs (276).
   a. Spring Coupled - Unclamped Flyweight Head – Remove screw (281) and lift out the centering spring coupling assembly (283). Then place the assembly in an inverted position. Loosen the two retaining screws (284), turning the retaining washers (285) to permit the flyweight head (286) to be removed from the pilot valve bushing and gear assembly (289).

NOTE: *Lightly scribe a match mark between the centering spring coupling assembly (283 or 295) and the flyweight head (286 or 298) to be re-matched at assembly if the clampscrew hole in the coupling is slotted rather than a single hole.*

   b. Spring Coupled - Oil Damped Flyweight Head Assembly – Remove screw (293) and lift out the centering spring coupling assembly (295). See note, above. Then remove the eight screws (296) around the flyweight head assembly (298) and separate the flyweight head from the pilot valve bushing and gear assembly (301).

4. Remove the cotter pins from one side of the flyweight pins (278) and remove the pins and flyweights.
5. Remove the snap ring (290) over the compensating bushing (291) and remove the pilot valve (292) and compensating bushing (291) from the pilot valve bushing and gear assembly.
6. Remove the centering bearing (288 or 299) from its seat in the pilot valve bushing assembly.

Power Cylinder with Reciprocating Shaft

1. Remove the power cylinder assembly (363) from the power case (330) by removing the four socket head screws (350).
2. To disassemble the power cylinder assembly, proceed as follows:
   a. Position the cylinder upright in an arbor press as shown on Fig. 27 to hold the spring guard (342) in place against the force of the power spring. Then remove the four socket head screws (340). Release the force applied to the arbor press and remove the spring guard (342), spring (344), and tail rod (347).
   b. Remove the cotter pin (355) and taper pin (356) from the rod end clevis.
   c. Apply the rod end puller tool as shown in Fig. 28 and remove the rod and clevis. USE CARE NOT TO BEND OR DAMAGE THE POWER PISTON ROD OR PISTON.

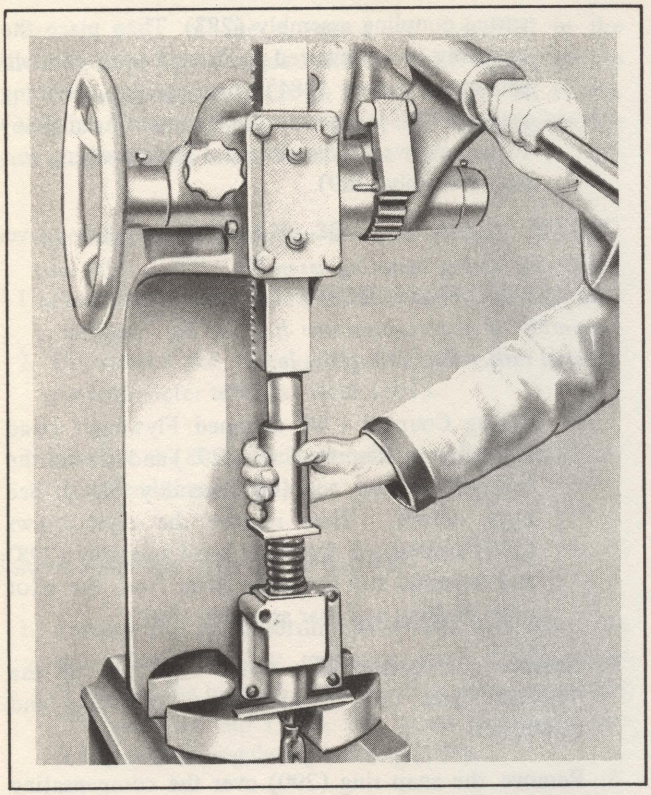


FIG. 27. REMOVING SPRING GUARD.

FIG. 27, E-8281

d. Push the power piston (358) out through the top of the power cylinder.

e. Remove the compensating needle valve (361) with O-ring (362) from the power cylinder.

f. Lightly grip the power cylinder in a vise and remove the oil seals (359 and 360) as shown in Fig. 29.

Base (Fig. 41)

1. Remove the base from the case by first removing the eight screws (303). Insert a screwdriver blade in the slots provided at the joint between the base and the case. Carefully pry the base evenly off its dowels.

2. Lift out the pump gears (307 and 308) and remove the base to case oil seal (305) from the groove in case.

Drive Shaft Assembly (Fig. 39)

1. Lightly clamp the base in a vise. Then remove the lockwire (364), the three cap screws (365) and the bearing retainer (366). Now pull the drive shaft and bearing from the base.

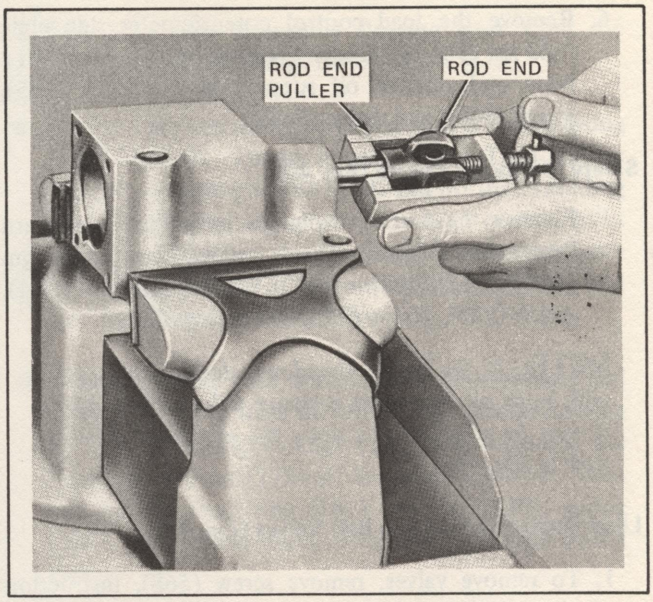


FIG. 28. REMOVING ROD END.

FIG. 28, E-8282

2. To remove the bearing (369) from the drive shaft, remove the snap ring (368) and press the shaft out using the arbor press.

3. Remove the oil seal retainer (370) and gasket (372). USE CARE NOT TO DAMAGE THE SEAL RETAINER.

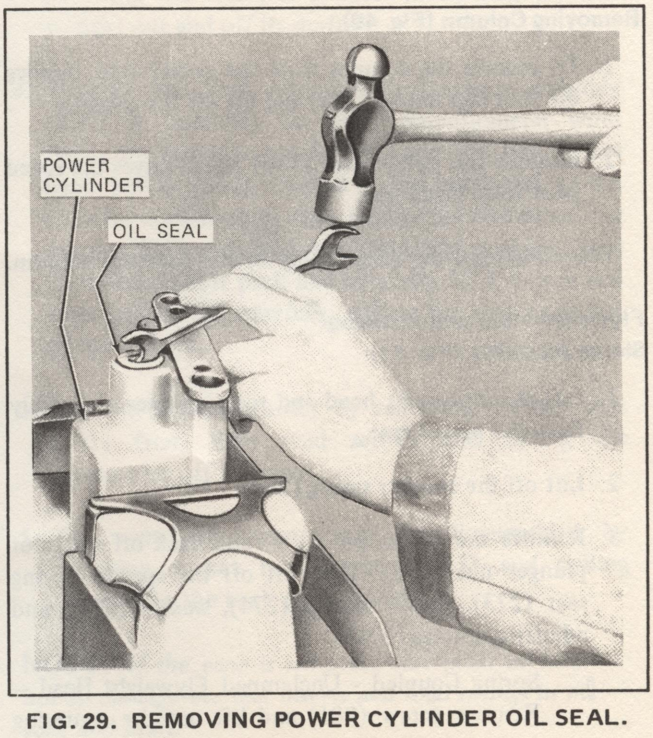


FIG. 29. REMOVING POWER CYLINDER OIL SEAL.

FIG. 29, E-8283

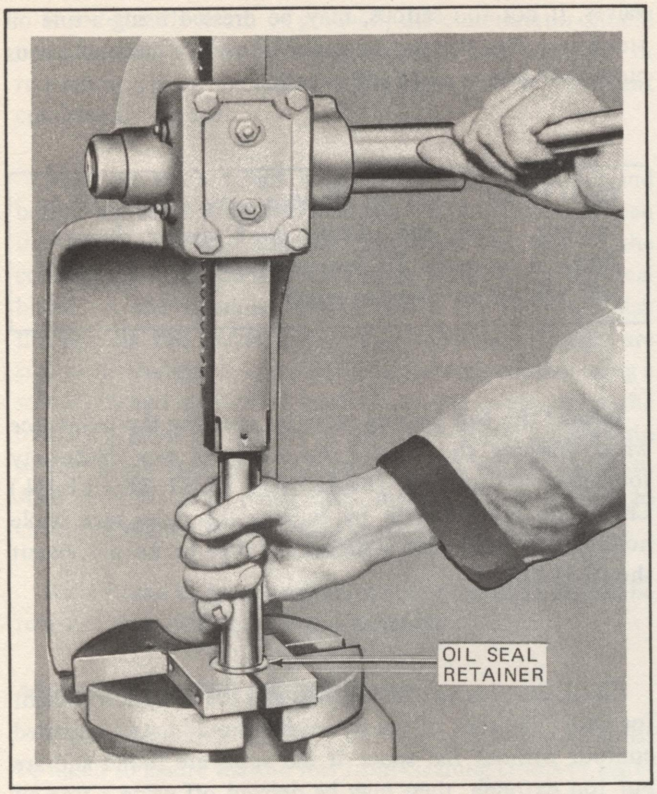


FIG. 30. REMOVING DRIVE SHAFT OIL SEAL.

FIG. 30, E-8285

4. Press the worn oil seal from the retainer using an arbor press as shown in Fig. 30.

Power Case (Fig. 41)

1. Remove the accumulator piston assemblies by placing the case in an arbor press as shown in Fig. 31. Place a rod against the accumulator spring seat (317), lightly compressing the springs while removing the snap rings (313). Remove the spring seats (317), Springs (115 and 116), and pistons (314).

2. If necessary, remove the check valve assemblies (310 and 311) from the power case as follows:

   To remove the inner check valves (311), pry the retainer plate from the check valve assembly and remove the springs and balls. To remove the outer check valves (310), press the balls through and out of the check valve case. Thread all four check valve cases with a 1/4-28 tap and using a 1/4-28 screw with a small plate and spacers, jack the four valve cases from the power case as shown in Fig. 32.

NOTE: *Check valves must be renewed if removed.*

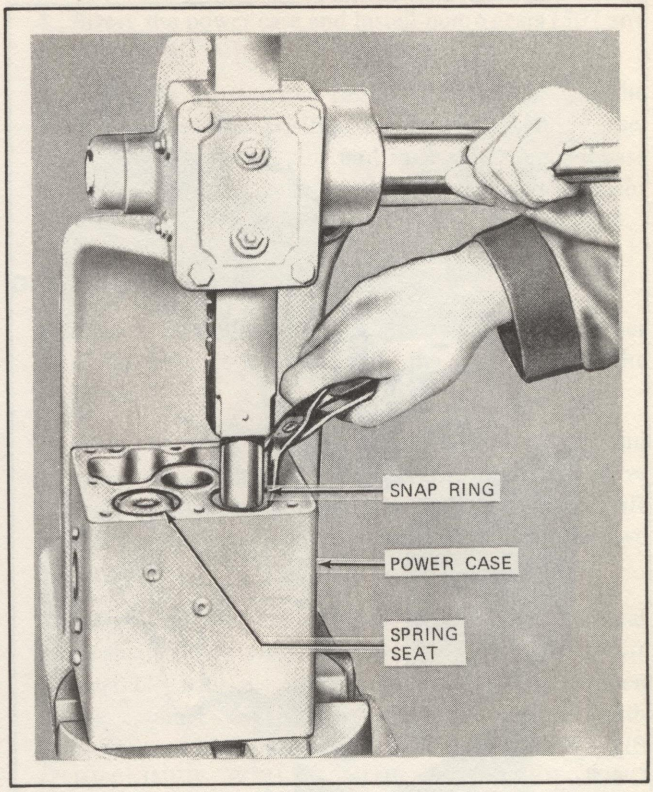


FIG. 31. REMOVING ACCUMULATOR SPRINGS AND PISTONS.

FIG. 31, E-8287

3. Remove the buffer piston assembly from the power case by removing the snap ring (324). Insert a 1/4-28 screw into the plug (325) and pull the plug from the power case. Remove the buffer springs (327), piston (328) and spring seat (329).

4. Remove the oil level gage (320) and gage elbow (321).

CLEANING AND INSPECTION OF GOVERNOR PARTS

CLEANING

All governor parts should be thoroughly cleaned of oil, dirt and used gasket material before beginning inspection. Parts of the various assemblies should be placed in the wire screen basket and suspended in an agitated cleaning solution for a sufficient time to permit dirt and varnish deposits to dissolve. Parts containing passages and cavities should be cleaned by forcing the cleaning solution through these passages. A stiff bristle brush will also be useful in cleaning surfaces of these parts. DO NOT USE WIRE BRUSHES OF ANY TYPE ON GOVERNOR PARTS.

Commercial chemical cleaners of the type used in cleaning locomotive electrical components may be used to

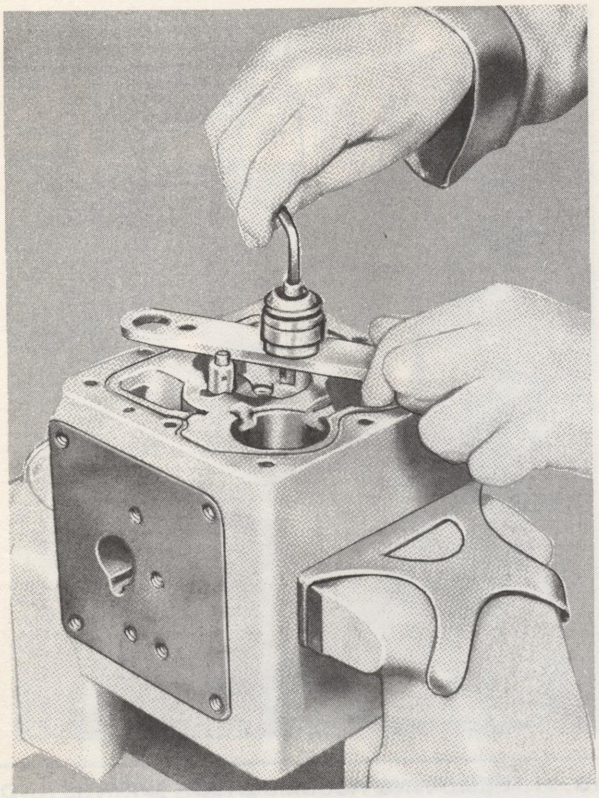


FIG. 32. REMOVING CHECK VALVE CASE.

FIG. 32, E-8288

clean governor parts so long as they are not injurious to the metal parts. In cases where suitable commercial cleaners are not available, governor parts can be cleaned using diesel fuel or kerosene.

After the parts are cleaned, if some time will elapse before the governor is reassembled, the parts should be protected against rusting and accumulating dust and dirt by coating them with diesel fuel or engine lube oil and then covering them with lint free cloths or clean paper.

INSPECTION

Inspection of a disassembled governor consists mainly of a visual and measurement inspection of its wearing parts such as: the pilot valve plungers and their bushings, the gears, bearings, pistons, etc. See GENERAL DATA near the end of this publication for dimensional data on parts in the power case.

The visual inspection consists of checking gear teeth, pistons and pilot valve plungers for uneven wear and scoring. Scoring on the pistons, piston bores and pilot valves, if not too serious, may be dressed using a fine oil stone and then the surface polished using a piece of crocus cloth or jeweler's rouge and a cloth.

CAUTION: *Edges on all pilot valve control lands, bushing, ports, and pistons must remain sharp to function properly. To remove or damage these edges will ruin the part beyond repair.*

Inspect the ball bearing races by spinning the outer race while grasping the bearing by its inner race. Note any roughness or catching. (BEARINGS MUST BE CLEAN.) Check the bearing wear by rocking the outer race while holding the inner race stationary. Little or no movement should be felt.

Check the pins, needle bearings and toe of each flyweight for wear. The toes of the flyweights should have a rounded contour without flat spots. If flat spots are found and are not too extreme, they may be dressed off using a fine oil stone, then polished with a piece of crocus cloth.

If the flyweight pins are worn, they may be interchanged with the flyweight limit pins as both pins are identical.

Visually check all linkage pins and parts for wear. Check that all springs are in good condition. Visually check the buffer springs and accumulation springs by comparing their respective free lengths.

If the top surface of the governor base is worn or scored in the area where the pump gears rotate, the surface may be flat-lapped or ground to correct the condition. DO NOT REMOVE MORE THAN 1/32 IN. OF MATERIAL FROM THE SURFACE.

Inspect the condition of the load control resistor pack and commutator. Using an ohmmeter, measure the total resistance of the pack by making contact between the last two wired segments at each side of the commutator. Also check the resistance between adjacent segments. The increments of resistance should be approximately equal on governors equipped with linear potentiometers. Visually inspect the commutator surface and brush contacts for wear or roughness.

If extensively worn or grooved, the commutator should be detached from the resistor pack and renewed or reconditioned by mounting it in a lathe and taking a light cut from its surface.

After the resistor pack is assembled in the governor and before the cover is applied, connect the ohmmeter between the brush arm lead and the lead from one side of the commutator. This connection can be made at the terminal block on the column. Slowly rotate the indicator disk through its full travel noting that resistance changes are steady. If readings are erratic, clean the commutator using a soft cloth and alcohol. If readings are still erratic, clean the oxidation from the surface of the commutator using a strip of fine grade sand paper, wrapped around the commutator. Also turn the sand paper over, making several strokes to clean and shape the contacting surface of the brushes.

Parts found to be excessively worn or damaged should be replaced with new parts during assembly.

ASSEMBLING THE GOVERNOR

While assembling the parts into the governor, care must be taken to assure that no lint from cleaning cloths or other foreign matter is on the parts. The governor may be assembled dry. If preferred, a small amount of clean lubricating oil can be applied to the parts as they are installed. New gaskets, O-rings and diaphragms should be used when reassembling the governor.

> **CAUTION:** *Do not use any type of sealing compound on gaskets or O-rings. Sealing compounds, if used, may foul the moving parts of the governor.*

Power Case (Fig. 41)

1. Install the pump check valves as follows:
   a. Press the pump suction check (311) into the power case with the check valve retainer plate facing the power case.
   b. Press the pump discharge check valves (310) into the power case with the check valve retainer plate facing away from the power case. See SPECIAL VALVE INSERTER TOOLS in tool catalog.
2. Insert the snap rings (313) into the gear pump end of the case. Place the case upright in an arbor press. Install and compress the accumulator springs (315 and 316) and insert the spring seats (317) and snap rings (313).
3. Install the buffer spring assembly into the power case, applying a new O-ring (326) to the buffer plug (325).
4. Invert the power case and install pump gears (307 and 308).
5. Insert the oil seal ring (305) into the groove in the power case. Now position the base (373) on the case, aligning the dowel pins and idler stud. Tap the base into position by using a soft hammer. Insert the eight bolts (303) with lockwashers and tighten securely.

Drive Shaft Assembly (Fig. 41)

1. Press a new oil seal (371) into the oil seal retainer (370) until it is flush with the end opposite the flange.
2. Press the bearing (369) onto the shaft (367) and apply snap ring (368). Temporarily insert the drive shaft into the pump gear spline and see that the shaft and gears rotate freely without binding. Then remove the shaft.
3. Install the oil seal retainer gasket (372), oil seal retainer (370) with the seal (371) and the shaft assembly with the shaft retainer ring (366). Tighten the retainer screws evenly and secure them with lockwire (364). DO NOT OVER-TIGHTEN THE RETAINER SCREWS. THE RETAINER RING DOES NOT SEAT AGAINST BASE.

Power Cylinder with Reciprocating Shaft (Fig. 41)

1. Press in the oil seal (360 and 359) together with their stamped part numbers facing outward. When in place, these seals should extend 0.005 in. below the outer surface of the housing.
2. Place the oil seal inserter, shown in the TOOL CATALOG, over the power piston rod and carefully insert the power piston into its cylinder.
3. Position the power cylinder (363) in an arbor press as shown in Fig. 33. Align the taper pin holes and press the rod end onto the power piston rod. (Apply force squarely against a small steel block placed in the rod end slot.)
4. Insert the taper pin (356) and tap it tightly into place. Then install the cotter pin (355).
5. Assemble the power spring (344) and power piston tail rod (347) to the power cylinder. Make sure the tail rod lift nut (348) is tight. Insert the lower end of the tail rod (347) into the yoke on nut (348) and adjust nut (346), at the lower end of the tail rod, to allow 0.003 in. free vertical movement of the tail rod in the yoke. Place the power cylinder upright in the arbor press and assemble the power spring (344) and spring guard (342) using a new gasket (343).

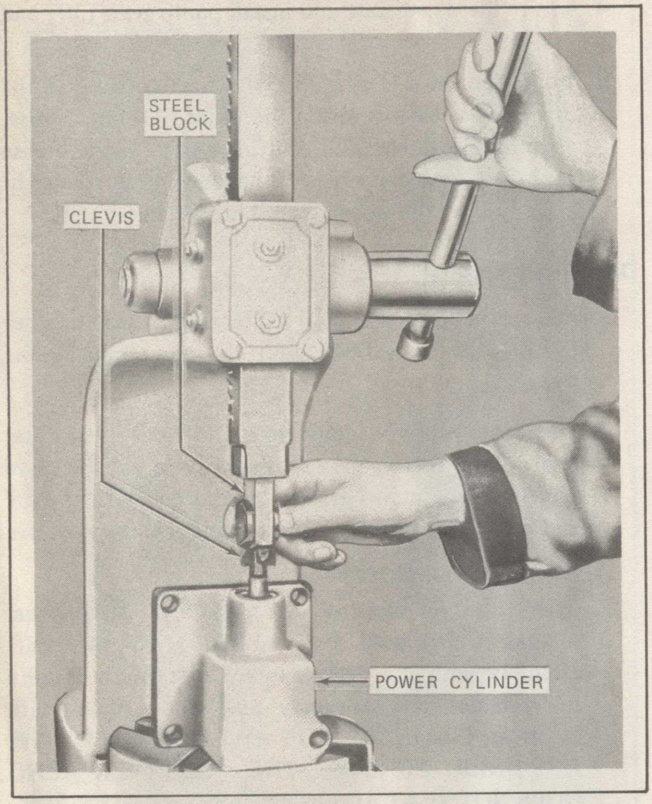


FIG. 33. INSTALLING POWER PISTON ROD CLEVIS.

FIG. 33, E-8289

6. Assemble the power cylinder to the power case. Place the seal spring (336), seal ring (335), and seal (334) over the spring guard (342). Assemble the cylinder to the power case using a new power cylinder gasket (352). Do not tighten the mounting screws until the tail rod linkage has been connected and the power cylinder is properly aligned. Then tighten mounting screws to 30 lb.-ft. torque.

NOTE: *It is important that the holes in the power cylinder gasket be properly aligned with the ports in the power case rather than those in the power cylinder.*

7. Install the compensating needle valve (361) with a new O-ring (362).

Power Cylinder with Rotary Terminal Shaft (Fig. 43)

1. If the terminal shaft bearings and seals were removed from the cylinder housing, install new bearings and seals with the housing positioned on the bench. Drive the shaft seals in squarely until they are flush with the outer surface of the case.
2. Lightly clamp the power cylinder into a vise. Apply a light coating of oil to the power piston and insert the piston into the cylinder. Apply pin (421) and stop nut (418) to the piston rod. Make sure the nut is securely locked.
3. Assemble the links (420), power lever (417), and pin (415) with the snap rings (414 and 419).
4. Install the terminal shaft using the seal inserter tool to protect the seals from being damaged. Insert and position the terminal shaft so that, when the rack dial segment is pinned in place, its indicator pointer coincides with the "OFF" mark on its scale while the power piston is at the bottom of its travel. Then properly position the shaft lengthwise and tighten the clamping screws (412) in the power lever.
5. Insert the tapered pin (406) through the rack dial segment and shaft and tighten screw (407).
6. See that the mechanism is free and can be moved through its full travel without binding.
7. Install the compensating needle valve (429) with a new O-ring (430). Replace the power cylinder cover (404) using a new gasket (405).
8. For assembly of the power spring, spring guard and tail rod, and the mounting of the power cylinder on the governor, see preceding instructions, "Power Cylinder With Reciprocating Shaft".

Flyweight Head and Rotating Sleeve Assembly (Fig. 41)

1. Place the pilot valve plunger (292) and the compensating bushing (291) into the pilot valve bushing assembly (289 or 301) and secure with the snap ring (290). Seat the ball bearing race (288 or 299) in the top of the pilot valve bushing assembly.
2. Assemble the flyweights (279) in the flyweight head (286 or 298) using pins (278) and new cotter pins (277).
3. Assemble the flyweight head over the pilot valve assembly. On the undamped flyweight head, turn the two retainer washers 180 degrees and tighten their mounting screws. On the oil damped flyweight head, install and tighten the screws around the flyweight mounting plate. Be sure the O-ring (300) is in place.
4. Fit the centering spring coupling assembly into the flyweight head, noting the key in the serations. If the clamping screw hole is slotted, align the register marks made at disassembly. Insert screw (281 or 293) with a lockwasher and tighten it securely. Be sure the flyweight head is free to rotate against its centering spring coupling assembly while the pilot valve bushing assembly is held stationary. The flyweight head should have equal travel in each direction and automatically return to its centered position when released.

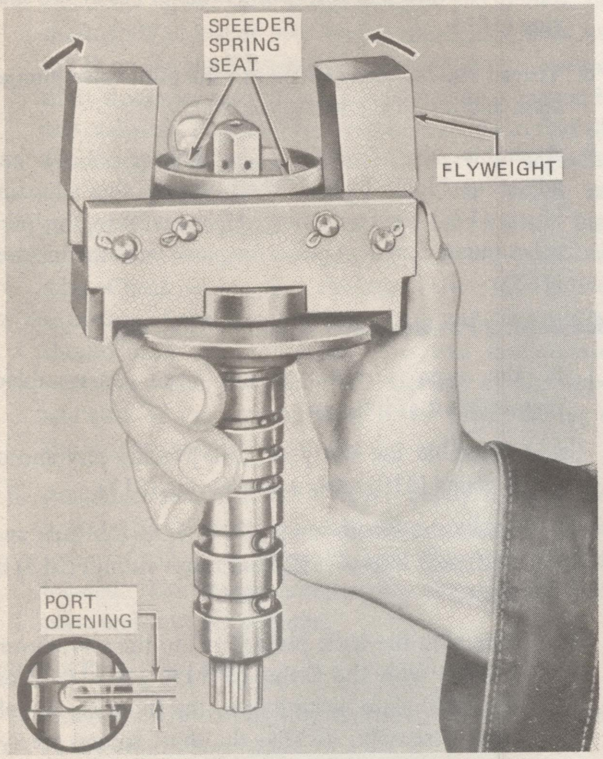


FIG. 34. CENTERING PILOT VALVE PLUNGER TRAVEL.

FIG. 34, E-8290

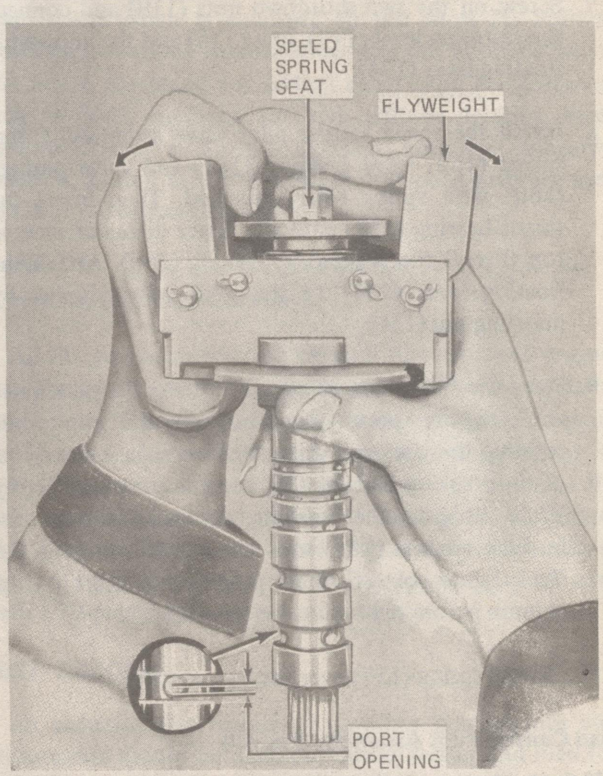


FIG. 35. CENTERING PILOT VALVE PLUNGER TRAVEL.

FIG. 35, E-8291

5. Assemble the adjusting spring (276), washer (275), thrust bearing (274) and speeder spring seat (273). Then install the shutdown rod (271) through the pilot valve plunger nut (270) and screw the nut onto the pilot valve plunger. (The thrust bearing race with the smaller hole fits against the speeder spring seat (273).

6. Center the pilot valve plunger as shown in Fig. 34 and 35. By applying pressure on the speeder spring seat and flyweights, move the valve plunger through its full travel and adjust the pilot valve plunger nut (270) until, as the flyweights are moved from their extreme inward position to their extreme outward position, the same amount of control land on the pilot valve plunger is showing in the control ports at each extreme. The control ports are the bottom row of holes in the pilot valve bushing assembly. When the adjustment is correct, secure the plunger nut (270) with a new cotter pin (269).

7. Insert the speeder spring (268) into the spring seat (273). (The spring must fit tightly into the seat).

8. Place the rotating bushing and flyweight assembly into the power case.

Column Assembly (Fig. 38, 39 and 40)

1. Install the speed setting pilot valve bushing gear (164) into the column. Assemble the column on the power case and install the four mounting screws (253). Tighten these screws to 15 lb.-ft. torque.

2. Install the bypass valve assembly (142).

3. Install the load control pilot valve assembly with the small O-ring in place in the column, then tighten screws (189) securely.

4. Insert the overriding valve spring (188) and plunger (187).

5. If the speed setting piston was removed from its cylinder, reassemble it. Using an arbor press, press the fulcrum block onto the piston rod. To prevent damaging the bottom edge of the piston, place a piece of wood or heavy paper between the piston and the press table.

6. Install the speed setting cylinder assembly with the triangular plate (105) and tighten the screws (127) securely. Note and insert the small O-ring under the speed setting cylinder.

7. Screw on the two shutdown nuts (119) and connect the restoring level (112), link (135) and the adjustable floating lever (174).

8. Install the speed setting pilot valve assembly. Insert spring (162) valve bushing (161) and valve plunger (160) with spring (163) attached. Then insert the thrust bearing (159) with the larger diameter race on top. Install the regulating bushing (158). Attach the floating lever (157) to the pilot valve plunger by inserting pin (156).

9. Place the "D" solenoid cup (155) over the pilot valve end. Lightly press downward on the cup while rotating the governor drive shaft to engage the spline of the rotating bushing (161) in the drive gear (164). While holding the bushing depressed, install the bushing retainer (154) with screw (150 and 148). Set the retainer pointer on the prick punch mark on the column before tightening the screw (148).

10. Install spring (137) over the bypass valve.

Load Control Pilot Assembly (Fig. 40)

If the load control pilot valve assembly was disassembled, reassemble and adjust it as follows:

1. Install the snap ring (203) in the load control bushing (202).

2. Install the load control bushing (202) in the column. Then install the load control pilot valve plunger (200), spring (201), gasket (199) and oil seal (197).

3. Press the cylinder head (196) into the column bore with the fingers.

4. Place the O-ring in the counter bore in the column; assemble the overriding cylinder housing (194) over the pilot valve stem and tighten the mounting screws (189).

5. Install the overriding piston (186). Hold the pilot valve plunger down against the snap ring (203). Using the special wrench supplied in the governor tool kit or its equivalent, thread the spring collar (185) onto the plunger stem. Turn the spring collar down until it just contacts the overriding piston. Then back it off 1/4 turn. (The plunger will begin to rise if the spring seat is turned down further after contacting the piston).

6. Lift the pilot valve sufficiently far to permit holding the spring collar (185) while securing it with the locknut (180). TO AVOID DAMAGING THE OIL SEAL, DO NOT LIFT THE PLUNGER HIGHER THAN NECESSARY.

7. Install the spring (183), spring retainer (182) and snap ring (181).

8. Thread the locknut (180) onto the pilot valve plunger stem and install the washer (179).

9. Assemble the floating lever linkage (174) and adjusting block (178). Then thread the adjusting block (178) approximately 10 turns onto the pilot valve plunger stem. Lock it in place with the locknut (180).

Load Control Potentiometer Assembly (Fig. 42)

1. If the vane servomotor has been disassembled, reassemble it as follows:
   a. Assemble the end plate (505) to the servomotor housing (510) using a new O-ring (511).
   b. Insert the rotary shaft (514) with the vane and shaft seal inserts (512) and insert springs (513) in place.
   c. Assemble the back plate (516) to the servomotor housing with the O-ring (511) in place. Position the back plate according to the indexing dowel. After assembly, see that the shaft rotates freely.

2. Install the load control oil supply valve assembly (567) into the column.

3. Insert the oil pressure failure assembly with a new gasket (235).

4. Insert the oil pressure shutdown valve plunger with a new diaphragm (221). Then attach the load control back plate (563) to the governor column with a new gasket (564).

NOTE: *On governors equipped with the combined low oil, low water pressure shutdown device, the load control back plate (230) can be installed previous to installing the safety shutdown mechanism.*

5. Install the brush arm drive shaft (537) and secure it in place with the snap ring (536). Apply new O-rings (517 and 518) and assemble the vane servomotor to the back plate (563 or 230).

NOTE: *The servomotor shaft is indexed to the brush drive shaft by a key in the shaft serrations.*

6. Install the resistor pack and commutator assembly (556). Use a stiff wire to pull the three potentiometer wires through the passage in the column to the terminal block (541). Attach the terminals to the terminal block. Be sure the wires are in good condition and are tight in the terminals.

7. Place the brush arm indicator disk (535) over the shaft (537). Install the lockwasher (533) and nut (532) on the shaft finger tight. Rotate the servomotor shaft clockwise until the servomotor vane is against its internal stop. Position the brush arm (535) so that the brushes are contacting the last two "active" segments of the commutator (two segments which are connected together). Tighten the nut (532), then rotate the disk and servomotor shaft counterclockwise. Check to see that full travel over the "active" segments of the commutator is obtained. The brushes should now be contacting the two commutator segments which are connected together on the opposite side of the commutator. If so, bend one lug of the lockwasher (533) into the slot in the nut (532).
8. Assemble the side plate cover (530) using a new gasket (531). Note the difference in length of the screws (522 and 523). Be sure they are properly located. The longer screws pass through the back plate and into the column.

Solenoid Pack (Fig. 38)

1. Insert the low oil pressure shutdown plunger assembly (245) into the column.
2. Mount the solenoid pack (94) on the column, engaging the toggle of the alarm switch into the hole in the shutdown plunger.
3. Connect the three wires from the solenoid pack to the load control terminal block, matching the wires according to their color.

Load Control Adjustable Ball Valves (Fig. 42)

1. Press the valve assemblies (577) into their openings in the column. These valve assemblies are interchangeable.
2. Install the retainer block (570), instruction plate (569) and secure with a screw (568).
3. On governors with fixed vane servomotor timing, replace the plugs in the valve ports if they were removed.

GOVERNOR OPERATION AND ADJUSTMENT ON THE TEST STAND

GENERAL

To properly adjust and test the operation of the governor, a Woodward governor test stand is needed. The test stand, shown in Fig. 36, model 205440, is an older, basic stand which is equipped to test most PG Railway Governors. Various modification kits are available which will adapt the stand for testing other type PG governors such as those equipped for high altitude derating, those equipped with a 32 volt external governor shutdown solenoid, as well as the Woodward overspeed governor used on GE7FDL Diesel Engines.

NOTE: *Refer to the TOOL CATALOG for the newest, improved test stand.*

All PG governors used on General Electric diesel engines are equipped with 12-point or 16-point electrical connectors. Therefore, with old test stands an 8 to 12-point or 16-point electrical adaptor connector is required to connect between the test stand and the governor as the basic test stand was supplied with an 8-point connector. This adaptor connector is listed with the governor tools in the tool catalog. New test stands, Fig. 36, are provided with both a 12-point and a 16-point connector.

TEST RECORD

An accurate test record of governor performance and adjustments should be filled out during testing and filed for future reference. A suggested sample test record form is shown in Fig. 37, Values given on this form are only examples. Correct values to be used on the form should be obtained from the GOVERNOR DATA sheet.

PRELIMINARY WORK

1. Mount the governor on the test stand using the proper spline drive adapter supplied with the stand. Be sure the governor base is resting firmly on the mounting surface. Apply and tighten the hold-down clamps. If the governor base does not set flat against the mounting surface, the test stand drive assembly must be lowered by applying the crank (supplied with the stand) to the screw in the center of the table-top. The bolts which fasten the drive assembly to the stand must also be loosened to allow the assembly to be moved.
2. Align and fasten the air motor control link to the governor power piston clevis, using the pin supplied with the test stand. Adjust the position of the link, starting at the first or second hole from the free end of the horizontal lever, to match the governor power piston travel to the air motor control valve.

NOTE: *For governors equipped with a rotary terminal shaft, a special linkage adaptor is required.*

3. Service the test stand oil tank to its correct level using the recommended type of oil. See TEST STAND INSTRUCTION.

4. Connect the test stand hoses to the governor as follows (see Fig. 1, 2 and 36):
   a. Governor Oil Pressure Hose – Connect to the accumulator pressure test opening in the power case marked (C) in Fig. 2.
   b. Oil In (Hot) – Connect to the opening marked (D) in Fig. 2.
   c. Oil Out (Drain to supply tank) – Connect to the drain opening in the power case marked (A) in Fig. 2.
   d. Engine Lube Oil Diaphragm Pressure Hose – Connect this hose to the engine oil pressure connection marked (B) in Fig. 2.
   e. Overspeed Fuel Shutoff Valve – Connect this hose to connection marked (E) in Fig. 2.
   f. Cap the ends of the hoses which are not used and prepare the valves as follows:
      (1) Close the load control pressure valve.
      (2) Open the vacuum valve fully.
   g. When testing governors equipped with the independent water and oil pressure failure shutdown devices, connect as follows:
      (1) Engine Lube Oil Diaphragm Pressure Hose – Connect hose to the engine oil supply port, marked (B) in Fig. 2.
      (2) Pneumatic Speed Control Air Pressure Hose – Connect hose to the engine water supply port, marked (F) in Fig. 2.
5. Remove the top cover from the governor and attach the 12-point or 16-point electric connector.

ADJUSTING THE TEST STAND AND HEATING GOVERNOR

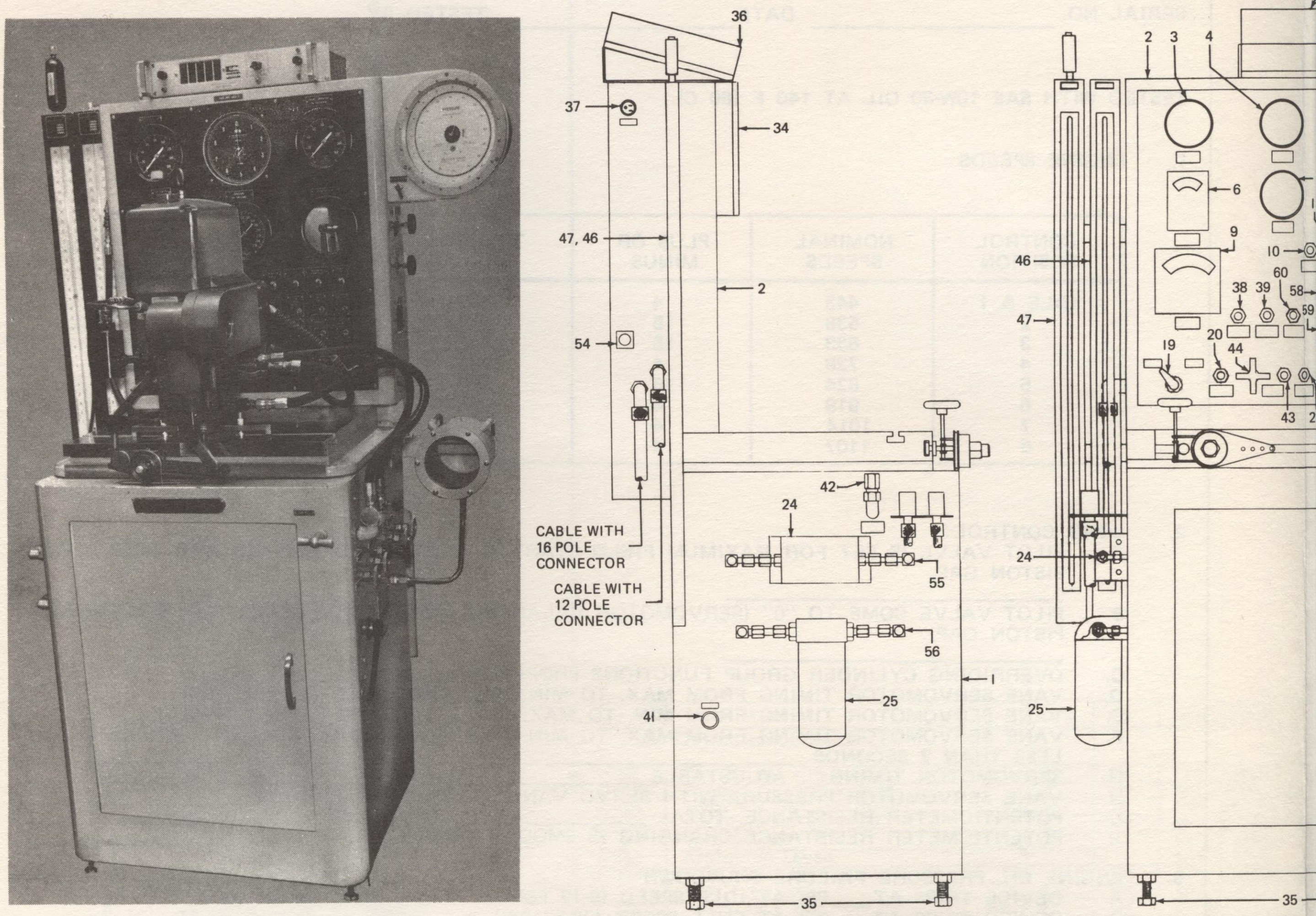
1. Close the master switch on the left side of the test stand.
2. Close the oil heater switch. The oil supply temperature should rise and be automatically controlled at 140 F or 60 C.
3. Position the test stand oil pump switch to FILL. The pump pressure should be automatically controlled at 75 psi. Circulate heated oil through the governor to heat the governor to operating temperature. Open the OIL OUT valve fully. Then partially open the OIL IN valve, using the valve to regulate the level of oil circulating through the governor. Continue circulating oil until the temperature of the governor reaches approximately 140 F (60 C).
4. Open the air supply to the test stand and adjust the pressure regulator to hold 80-90 psi, indicated on the gage at the regulator.
5. Adjust the oil pressure supplied to the engine oil pressure failure diaphragm to 35-50 psi by manipulating the lube oil pressure supply and pressure bleed valves on the right side of the test stand.
6. On governors equipped with a cooling water pressure failure shutdown device, set the air pressure applied to the water pressure diaphragm at 25-30 psi by adjusting the pneumatic transmitter control valve.
7. On governors equipped with Overspeed Fuel Shutoff Valve, open valve 19 in Fig. 36.
8. Position the air motor reversing valve to either clockwise or counterclockwise rotation.
9. After the governor is heated, adjust the level of the oil to be between the lines on the governor gage. Then fully close the OIL IN and OIL OUT valves.

TESTING THE GOVERNOR

During the following governor tests and adjustments, the speed adjusting knob for the air motor must be periodically readjusted to maintain the governor power piston within its operating range. This is required to assure that the governor is at all times controlling the test stand speed. Turning the air motor speed adjusting knob will reposition the air motor throttle valve. In effect this repositions the operating point of the governor power piston.

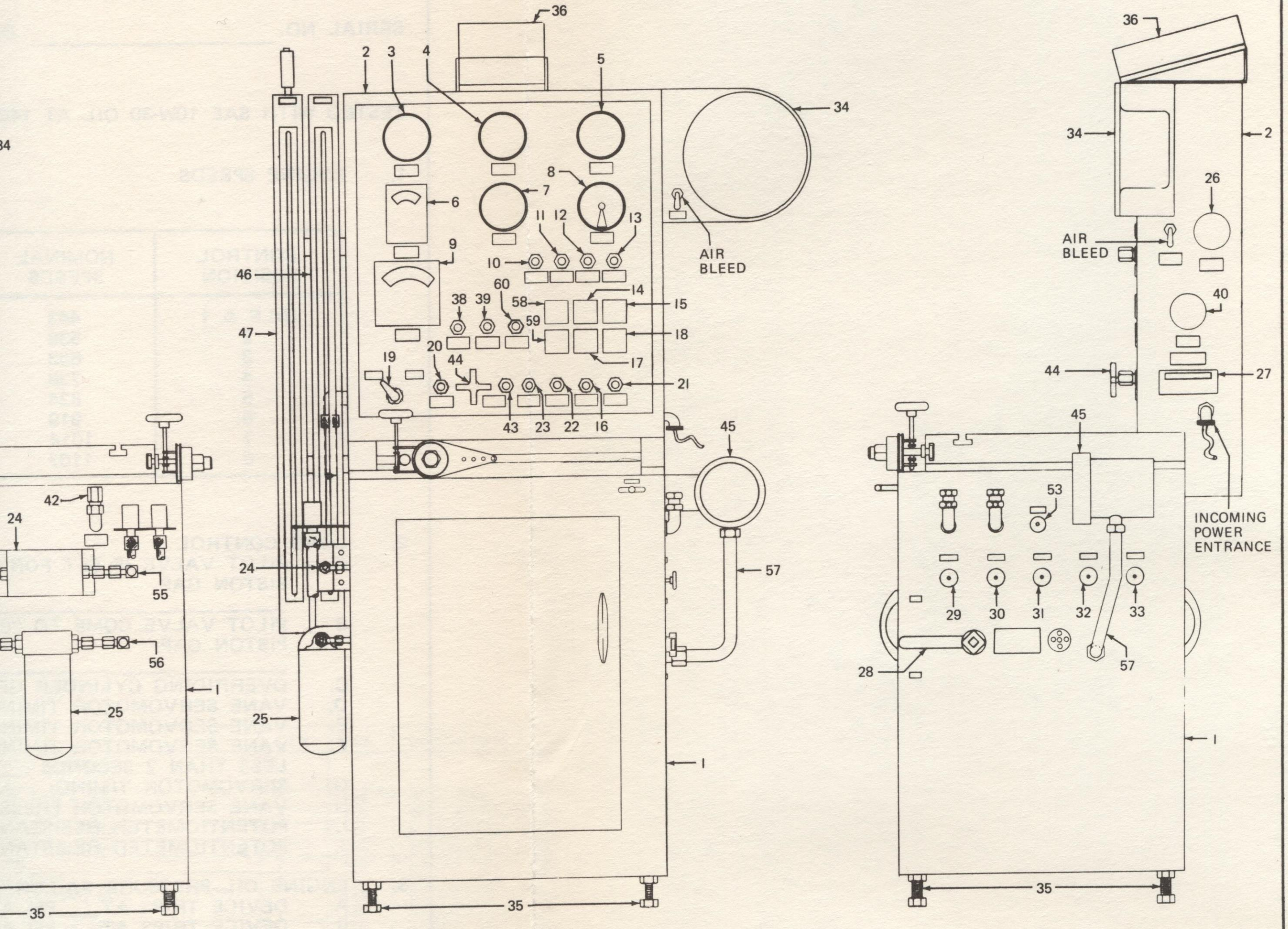
1. Position the speed selector switch to IDLE position and start the governor operating by turning the air motor speed adjusting knob clockwise. The governor should now be operating at or near its idle speed setting and controlling the speed of the air motor. The governor accumulator oil pressure, indicated on the panel gage should be approximately 100 psi.
2. Operate the governor for 15 minutes in each direction. During the run-in period, check to see that the load control potentiometer housing is filled with oil and that the oil level is correct in the sight gage. Check the governor for leaks. If found, make the necessary corrections.
3. Vent the governor system of trapped air by partially backing out one of the vent plugs in the power case and opening the compensating needle valve approximately five turns. Cause the governor speed to surge by lightly pulling and releasing the cable which is attached to the air motor throttle valve.

FIG. 36, E-22692A



REF.	DESCRIPTION	REF.	DESCRIPTION	REF.	DESC
1	CABINET ASSEMBLY	20	AIR SHUTDOWN CONNECTION	40	PRES
2	INSTRUMENT PANEL ASSEMBLY	21	WATER SHUTDOWN CONNECTION	41	AIR
3	WATER PRESSURE GAGE, 0-30 PSI	22	GOVERNOR OIL PRESSURE CONNECTION	42	GOV
4	ENG. LUBRICATING OIL DIAPHRAGM PRESSURE	23	ENG. LUBRICATING OIL DIAPHRAGM	43	LOA
	GAGE 0-60 PSI	24	MICRO FOG LUBRICATOR	44	LOA
5	GOVERNOR OIL PRESSURE GAGE 0-300 PSI	25	OIL FILTER	45	VAC
6	LOAD CONTROL RHEOSTAT TEST METER	26	WATER SD PRESSURE REGULATOR	46	WEL
7	VANE SERVO INDICATOR	27	CIRCUIT BREAKER	47	WEL
8	SPEED SELECTOR SWITCH (INCLUDE LOW IDLE	28	AIR MOTOR REVERSING VALVE	48	ROT
	"A" AND "D" SOLENOIDS ENERGIZED)	29	GOVERNOR DRAIN VALVE	49	2.5:1
9	OIL TEMPERATURE REGULATOR	30	FILL AND DRAIN VALVE	50	SERV
10	LOW WATER ALARM INDICATING LIGHT	31	PRESSURE REGULATOR VALVE	51	OIL
11	LOAD CONTROL INDICATING LIGHT	32	PRESSURE SUPPLY VALVE	52	THE
12	PRESSURE VACUUM ALARM INDICATING LIGHT	33	PRESSURE BLEED VALVE	53	VAC
13	POWER ON INDICATING LIGHT	34	HG MANOMETER (0-60 IN. HG GAGE	54	OIL
14	LOAD CONTROL SWITCH		PRESSURE)	55	PNEU
15	"OIL PUMP" 3 PDT CTR. OFF SWITCH	35	LEVELING BOLT (4), 3/4-10	56	HYD
16	MANOMETER CONNECTION	36	DIGITAL ELECTRONIC COUNTER	57	VAC
17	"HEATERS" SPST SWITCH	37	CONVENIENCE OUTLET, 120 VAC	58	VAC
18	"OVERRIDING SOLENOID" SPST SWITCH	38	SERVO INCREASE CONNECTION	59	OIL
19	3-WAY AIR VALVE	39	SERVO DECREASE CONNECTION	60	ENG

*EQUIPMENT NOT SHOWN ON DRAWING BUT SHIPPED WITH TEST STAND.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AIR BLEED
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36
34
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AIR BLEED
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27
45
53
INCOMING POWER ENTRANCE
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32
33
28
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	REF.	DESCRIPTION	REF.	DESCRIPTION
	20	AIR SHUTDOWN CONNECTION	40	PRESSURE REGULATOR FOR MANOMETER
	21	WATER SHUTDOWN CONNECTION	41	AIR INLET CONNECTION
	22	GOVERNOR OIL PRESSURE CONNECTION	42	GOVERNOR DRAIN
SURE	23	ENG. LUBRICATING OIL DIAPHRAGM	43	LOAD CONTROL PRESSURE
	24	MICRO FOG LUBRICATOR	44	LOAD CONTROL PRESSURE VALVE
	25	OIL FILTER	45	VACUUM TRAP
	26	WATER SD PRESSURE REGULATOR	46	WELL TYPE VACUUM MANOMETER
	27	CIRCUIT BREAKER	47	WELL TYPE PRESSURE MANOMETER
DLE	28	AIR MOTOR REVERSING VALVE	48	ROTARY SERVO LINKAGE*
	29	GOVERNOR DRAIN VALVE	49	2.5:1 SPEED INCREASER*
	30	FILL AND DRAIN VALVE	50	SERVO LINKAGE KIT*
	31	PRESSURE REGULATOR VALVE	51	OIL LEVEL CONTROLLER*
	32	PRESSURE SUPPLY VALVE	52	THERMOMETER AND HOLDER*
IGHT	33	PRESSURE BLEED VALVE	53	VACUUM REGULATOR VALVE
	34	HG MANOMETER (0-60 IN. HG GAGE PRESSURE)	54	OIL LEVEL CONTROL CONNECTOR
			55	PNEUMATIC PIPE ASSEMBLY
	35	LEVELING BOLT (4), 3/4-10	56	HYDRAULIC PIPE ASSEMBLY
	36	DIGITAL ELECTRONIC COUNTER	57	VACUUM PIPE ASSEMBLY
	37	CONVENIENCE OUTLET, 120 VAC	58	VACUUM PIPE DPST SWITCH
	38	SERVO INCREASE CONNECTION	59	OIL LEVEL CONTROL SWITCH W/N.P.
	39	SERVO DECREASE CONNECTION	60	ENGINE LUBRICATING OIL VACUUM CONNECTION

PED WITH TEST STAND.

FIG. 36. TYPICAL GOVERNOR TEST STAND.

MODEL NO. ____________

SERIAL NO. ____________ DATE ____________ TESTED BY ____________

TESTED WITH SAE 10W-30 OIL AT 140 F (60 C).

1. ENGINE SPEEDS

CONTROL POSITION	NOMINAL SPEEDS	PLUS OR MINUS	TOLERANCE BRACKET	ACTUAL SPEED
IDLE & 1	443	4	439-447	
2	538	15	523-553	
3	633	15	618-648	
4	729	4	725-733	
5	824	15	809-839	
6	919	4	915-923	
7	1014	4	1010-1018	
8	1107	4	1103-1111	

2. LOAD CONTROL
   - A. PILOT VALVE IS SET FOR MAXIMUM FIELD START AT IDLE SPEED SETTING AND 1.000 POWER PISTON GAP. ____________
   - B. PILOT VALVE COME TO "0" (SERVOMOTOR BALANCED) AT NOTCH 8 SPEED AND 0.344 POWER PISTON GAP. ____________
   - C. OVERRIDING CYLINDER GROUP FUNCTIONS PROPERLY ____________
   - D. VANE SERVOMOTOR TIMING FROM MAX. TO MIN. IS ____ SECONDS (20 SECONDS)
   - E. VANE SERVOMOTOR TIMING FROM MIN. TO MAX. IS ____ SECONDS (30 SECONDS)
   - F. VANE SERVOMOTOR TIMING FROM MAX. TO MIN. WITH OVERRIDING SOLENOID ENERGIZED IS LESS THAN 2 SECONDS ____________
   - G. SERVOMOTOR TIMING: ADJUSTABLE ____________ FIXED: ____________
   - H. VANE SERVOMOTOR PRESSURE WITH SERVO VANE STATIONARY 25-50 PSI ____________
   - I. POTENTIOMETER RESISTANCE, TOTAL ____________ (44 OHMS) ____________
   - J. POTENTIOMETER RESISTANCE CHANGING IS SMOOTH OVER FULL TRAVEL ____________.

3. ENGINE OIL PRESSURE FAILURE SHUTDOWN
   - A. DEVICE TRIPS AT ____ PSI AT IDLE SPEED (5-12 PSI)
   - B. DEVICE TRIPS AT ____ PSI AT FULL SPEED (36-52 PSI)
   - C. TRIP TIME DELAY AT IDLE ____________ SECONDS (SHOULD BE 35-45 SECONDS)
   - D. TRIPS INSTANTLY AT NOTCH 2 AND ABOVE ____________
   - E. SIGNAL SWITCH ADJUSTED AND OPERATING PROPERLY ____________

4. ENGINE WATER PRESSURE FAILURE SHUTDOWN
   - A. DEVICE TRIPS AT ____ PSI AT NOTCH 2 (0-3 PSI).
   - B. DEVICE TRIPS AT ____ PSI AT NOTCH 8 (10-18 PSI).

5. GOVERNOR ACCELERATING TIME FROM 443 TO 1107 RPM ____ SECONDS (7-22 SECONDS)

6. START FUEL LIMITING LEVER AND SHUTDOWN NUTS WERE SET ____________.

7. SHUTDOWN STOP SCREW WAS SET ____________.

8. THE GOVERNOR SHUTS DOWN IF:
   - A. THE SHUTDOWN PLUNGER IS PUSHED IN OR PULLED OUT ____________.
   - B. PRESSURE IS REMOVED FROM THE WATER PRESSURE FAILURE SHUTDOWN ____________.
   - C. PRESSURE IS REMOVED FROM THE OIL PRESSURE FAILURE SHUTDOWN ____________.
   - D. GOVERNOR CONTROL IS POSITIONED TO OFF ____________.

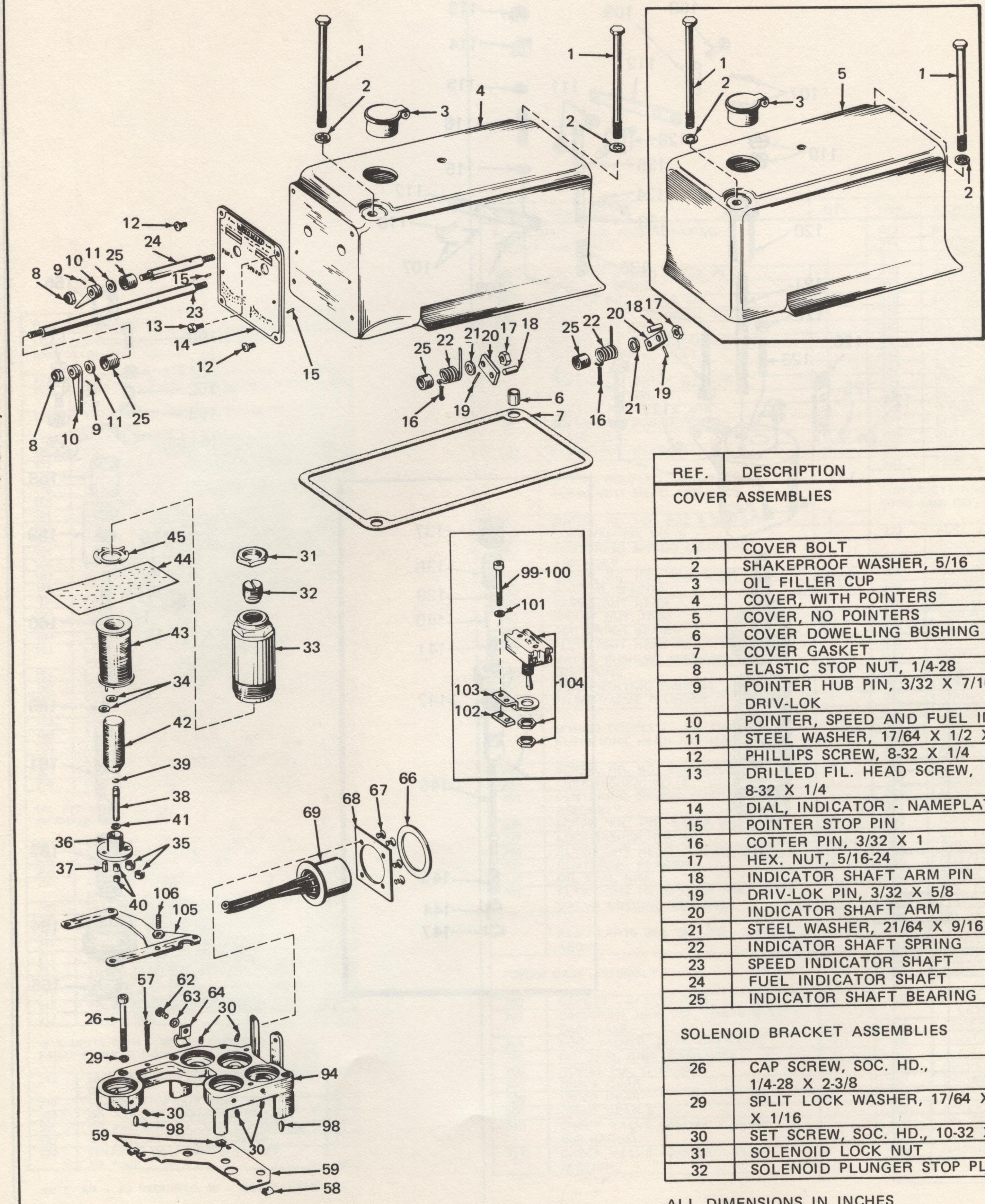
9.
   - A. GOVERNOR IS FREE OF OIL LEAKS ____________.
   - B. HUNTING OR JIGGLING IS NOT EXCESSIVE ____________.

10. ALL ADJUSTMENTS ARE SECURED AND LOCKING DEVICES ARE IN PLACE ____________.

FIG. 37. SAMPLE TEST RECORD.

FIG. 37, E-22693

FIG. 38, E-9543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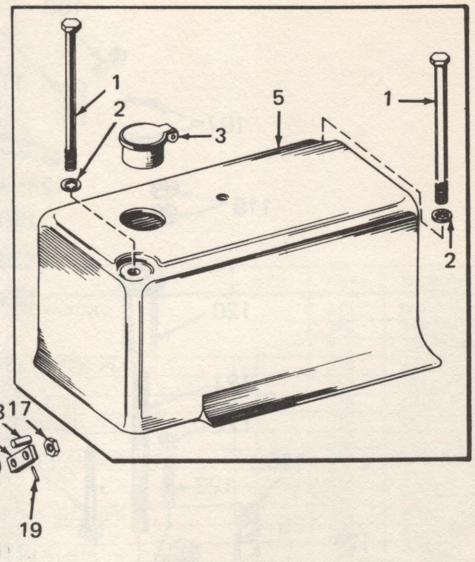
REF.	DESCRIPTION
	COVER ASSEMBLIES
1	COVER BOLT
2	SHAKEPROOF WASHER, 5/16
3	OIL FILLER CUP
4	COVER, WITH POINTERS
5	COVER, NO POINTERS
6	COVER DOWELLING BUSHING
7	COVER GASKET
8	ELASTIC STOP NUT, 1/4-28
9	POINTER HUB PIN, 3/32 X 7/16 DRIV-LOK
10	POINTER, SPEED AND FUEL INDICATOR
11	STEEL WASHER, 17/64 X 1/2 X 1/32
12	PHILLIPS SCREW, 8-32 X 1/4
13	DRILLED FIL. HEAD SCREW, 8-32 X 1/4
14	DIAL, INDICATOR - NAMEPLATE
15	POINTER STOP PIN
16	COTTER PIN, 3/32 X 1
17	HEX. NUT, 5/16-24
18	INDICATOR SHAFT ARM PIN
19	DRIV-LOK PIN, 3/32 X 5/8
20	INDICATOR SHAFT ARM
21	STEEL WASHER, 21/64 X 9/16 X 1/16
22	INDICATOR SHAFT SPRING
23	SPEED INDICATOR SHAFT
24	FUEL INDICATOR SHAFT
25	INDICATOR SHAFT BEARING (OILITE)
	SOLENOID BRACKET ASSEMBLIES
26	CAP SCREW, SOC. HD., 1/4-28 X 2-3/8
29	SPLIT LOCK WASHER, 17/64 X 27/64 X 1/16
30	SET SCREW, SOC. HD., 10-32 X 1/4
31	SOLENOID LOCK NUT
32	SOLENOID PLUNGER STOP PLUG

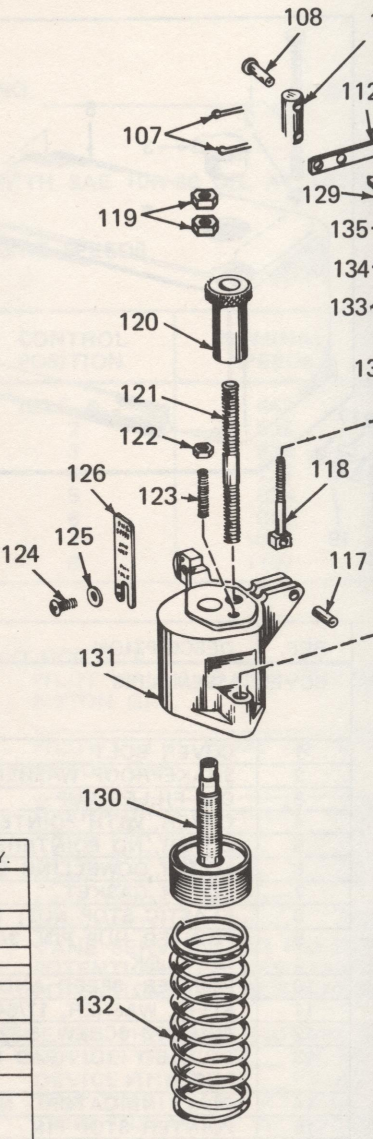
ALL DIMENSIONS IN INCHES



REF.	DESCRIPTION	QTY.
	COVER ASSEMBLIES	
1	COVER BOLT	2
2	SHAKEPROOF WASHER, 5/16	2
3	OIL FILLER CUP	1
4	COVER, WITH POINTERS	1
5	COVER, NO POINTERS	1
6	COVER DOWELLING BUSHING	2
7	COVER GASKET	1
8	ELASTIC STOP NUT, 1/4-28	2
9	POINTER HUB PIN, 3/32 X 7/16 DRIV-LOK	2
10	POINTER, SPEED AND FUEL INDICATOR	2
11	STEEL WASHER, 17/64 X 1/2 X 1/32	2
12	PHILLIPS SCREW, 8-32 X 1/4	3
13	DRILLED FIL. HEAD SCREW, 8-32 X 1/4	1
14	DIAL, INDICATOR - NAMEPLATE	1
15	POINTER STOP PIN	2
16	COTTER PIN, 3/32 X 1	2
17	HEX. NUT, 5/16-24	2
18	INDICATOR SHAFT ARM PIN	2
19	DRIV-LOK PIN, 3/32 X 5/8	2
20	INDICATOR SHAFT ARM	2
21	STEEL WASHER, 21/64 X 9/16 X 1/16	2
22	INDICATOR SHAFT SPRING	2
23	SPEED INDICATOR SHAFT	1
24	FUEL INDICATOR SHAFT	1
25	INDICATOR SHAFT BEARING (OILITE)	4
	SOLENOID BRACKET ASSEMBLIES	
26	CAP SCREW, SOC. HD., 1/4-28 X 2-3/8	3
29	SPLIT LOCK WASHER, 17/64 X 27/64 X 1/16	3
30	SET SCREW, SOC. HD., 10-32 X 1/4	5
31	SOLENOID LOCK NUT	5
32	SOLENOID PLUNGER STOP PLUG	5
33	SOLENOID CASE	5
34	SOLDERING SHIELD WASHER	10
35	VARNISHED TUBING	10
36	SOLENOID PLUNGER GUIDE	5
37	SOLENOID PLUNGER GUIDE LOCATING PIN	5
38	SOLENOID PLUNGER ROD	5
39	SOLENOID PLUNGER ROD SNAP RING	5
40	SOLENOID PLUNGER GUIDE BUSHING	10
41	SOLENOID PLUNGER WASHER	5
42	SOLENOID PLUNGER	5
43	SOLENOID COIL	5
44	SOLENOID COIL INSULATING PAPER	5
45	SOLENOID LOAD SPRING	5
57	SCREW, ROUND HEAD, PARKER KALON NO. 8 X 1-1/4	3
58	SPEED NUT, NO. 8	3
59	WIRING COVER	1
62	SCREW, RD. HD., 8-32 X 3/8	2
63	WASHER, NO. 8 SHAKEPROOF	2
64	WIRE CLAMP (2 WIRE)	2
66	GASKET (ELECT. CONN. PLATE)	1
67	SCREW, FLAT HD., 10-32 X 3/8	4
68	ELECTRICAL CONNECTOR PLATE	1
69	ELECTRICAL CONNECTOR ASSEMBLY	1
	SPEED SETTING BRACKETS	
94	SOLENOID PACK ASSEMBLY	1
98	BRACKET DOWELS, 1/4 X 9/16 DRIV-LOK	2
99	CAP SCREW, SOC. HD., 10-32 X 2 1/4	2
101	WASHER, NO. 10 SPLIT LOCK	2
102	SWITCH BRACKET CLAMP PLATE	1
103	SIGNAL SWITCH MOUNTING BRACKET	1
104	SIGNAL SWITCH (LUBE OIL FAILURE)	1
105	TRIANGULAR PLATE ASSEMBLY	1
106	BYPASS SCREW (IN TRIANGULAR PLATE)	1

ALL DIMENSIONS IN INCHES

FIG. 38. COVERS, POINTERS, AND TOP OF COLUMN PARTS.



REF.	DESCRIPTION	QTY.
SPEED SETTING SERVO ASSEMBLY		
107	COTTER PIN, 1/16 X 3/8	4
108	HEADED PIN, 3/16 X 25/32	2
109	PIVOT PIN LINK, 1/2 DIAM.	1
110	STRAIGHT PIN, 1/8 DIAM.	1
111	LINK SPACER	2
112	RESTORING LEVER	2
113	BASE SPEED SETTING NUT, 10-32 FLEX LOK	1
114	ADJUSTABLE FULCRUM PIN	1
115	FULCRUM SPRING WASHER	2
116	ADJUSTABLE FULCRUM SPRING	1
117	FULCRUM SCREW HINGE PIN	1
118	ADJUSTABLE FULCRUM SCREW	1
119	SHUTDOWN NUTS, 8-32 HEX.	2
120	MANUAL SPEED SETTING TOOL	1
121	MANUAL SPEED SETTING STUD	1
122	LOCK NUT, 10-32 HEX.	1
123	SPEED SETTING PISTON STOP SCREW	1
124	SCREW, PHIL. RD. HD., 10-32 X 3/8	1
125	WASHER, 13/64 X 7/16 X 1/32	1
126	SPEED INDICATOR SCALE	1
127	CAP SCREW, HEX. HD., 1/4 -28 X 1-3/8	2
128	WASHER, 17/64 X 1/2 X 1/32	2
129	SPEED SETTING PISTON FULCRUM ASSEMBLY	1
130	SPEED SETTING PISTON ASSEMBLY	1
131	SPEED SETTING CYLINDER ASSEMBLY	1
132	SPEED SETTING PISTON SPRING	1
133	COTTER PIN, 1/16 X 3/8	2
134	RESTORING LINK PIN, 1/8 X 47/64	1
135	RESTORING LINK	1
136	RESTORING LINK SPRING	1
BYPASS VALVE ASSEMBLY		
137	SOLENOID COUNTER BALANCE SPRING	1
138	SEAL RETAINING NUT	1
139	SEAL RING	1
140	SEAL SPRING RETAINER	1
141	SEAL SPRING	1
142	BYPASS VALVE BODY	1
143	VALVE SPRING SEAT PIN, 1/16 X 13/32	
144	VALVE SPRING SEAT	1
145	VALVE SPRING	1
146	BYPASS VALVE PLUNGER	1
147	O-RING (VALVE BODY)	1
SPEED SETTING PILOT VALVE AND BUSHING ASSEMBLY		
148	BUSHING RETAINER SCREW	1
149	WASHER, 17/64	1
150	CAP SCREW, HEX. HD. 1/4-28 X 3/4	1
151	BUSHING RETAINER SPRING	1
152	RETAINER SPRING COLLAR	1
153	RETAINER SPRING WASHER, 21/64	1
154	REGULATING BUSHING RETAINER	1
155	"D" SOLENOID CUP WITH PIN	1
156	PILOT VALVE PIN	1
157	FLOATING LEVER ASSEMBLY	1
158	REGULATING BUSHING	1
159	THRUST BEARING (COMPLETE - 3 PCS.)	1
160	PILOT VALVE PLUNGER	1
161	PILOT VALVE BUSHING	1
162	PILOT VALVE BUSHING SPRING	1
163	PILOT VALVE PLUNGER SPRING	1
164	PILOT VALVE BUSHING DRIVE GEAR	1
165	BEARING STUD	1
168	COTTER PIN, 1/16 X 3/8	2

ALL DIMENSIONS IN INCHES

FIG. 39. SPEED SETTING SERVO, BYPASS VALVE, SPEED SETTING PILOT VALVE AND BUSHING.

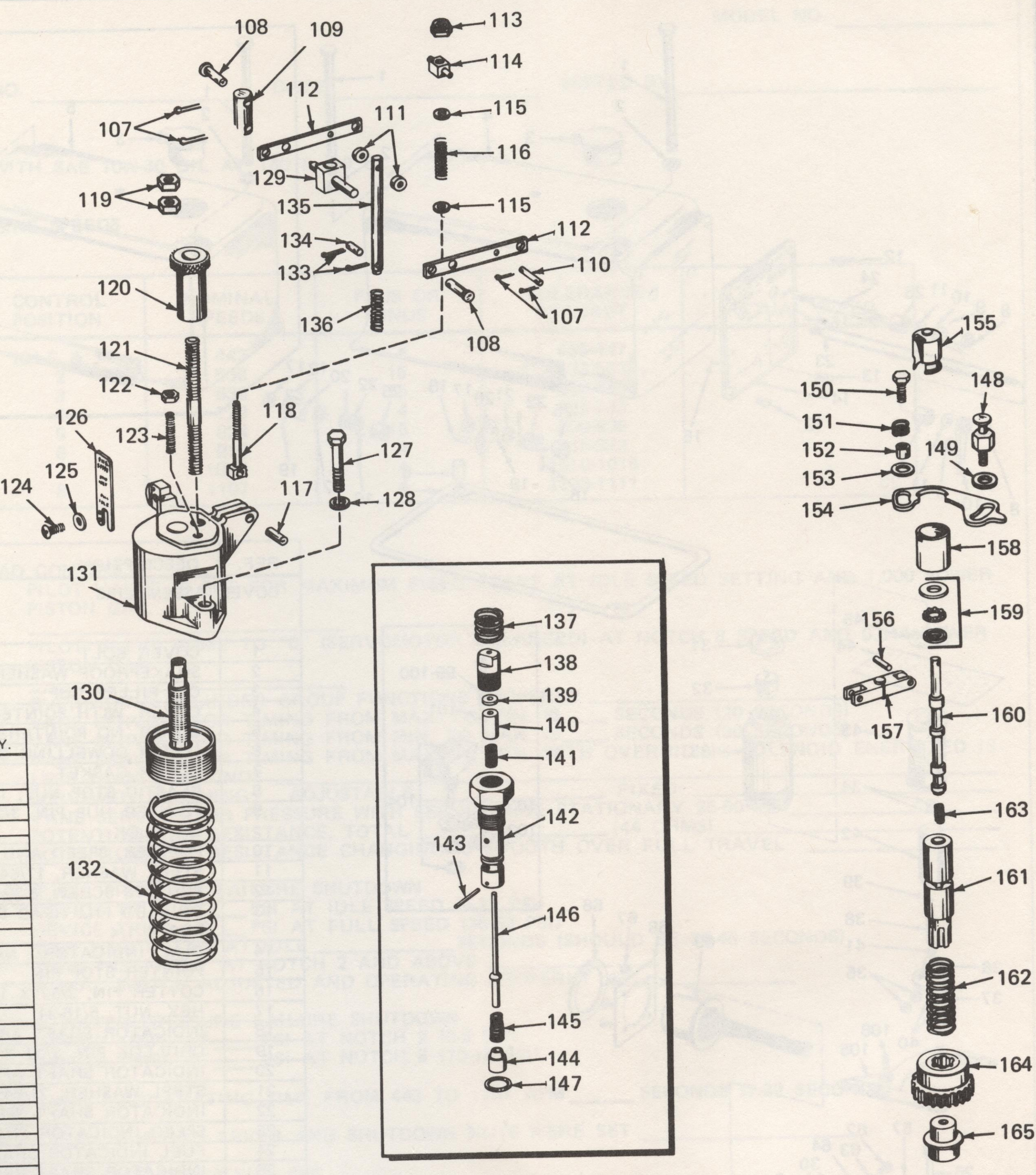

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FIG. 39, E-9544

	QTY.
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	1
UNGER	1
DY)	1
VE AND	
R SCREW	1
	1
HD. 1/4-28 X 3/4	1
R SPRING	1
COLLAR	1
WASHER, 21/64	1
IING RETAINER	1
P WITH PIN	1
	1
ASSEMBLY	1
IING	1
(COMPLETE - 3 PCS.)	1
NGER	1
HING	1
HING SPRING	1
NGER SPRING	1
HING DRIVE GEAR	1
	1
X 3/8	2

ILOT VALVE AND BUSHING.

FIG. 40, E-11766

REF.	DESCRIPTION	QTY.
	LOAD CONTROL PILOT VALVE ASSEMBLY AND OVERRIDING VALVE	
172	COTTER PIN, 1/16 X 3/8	3
173	HEADED PIN, 3/16 X 25/32 (TAIL ROD)	1
174	ADJUSTABLE FLOATING LEVER ASSEMBLY	1
175	BRONZE LOCKWIRE 0.035 X 2	1
176	SOC. HD. CAPSCREW, 1/4-28 X 3/4	1
177	LOAD CONTROL VALVE ECCENTRIC	1
178	ADJUSTING BLOCK	1
179	LOAD CONTROL INDICATOR WASHER	1
180	LOCKNUT, 5/16-24	2
181	SPRING RETAINER SNAP RING	1
182	LOAD CONTROL SPRING RETAINER	1
183	OUTER LOAD CONTROL VALVE SPRING	1
185	LOAD CONTROL VALVE SPRING COLLAR	1
186	OVERRIDING PISTON	1
187	OVERRIDING VALVE PLUNGER	1
188	OVERRIDING VALVE PLUNGER SPRING	1
189	CAPSCREW, HEX. HD., 1/4-28 X 1	2
190	SLPIT LOCKWASHER, 17/64	2
191	PHIL. SCREW, 10-32 X 1/4	1
192	WASHER, 13/64 X 7/16 X 1/32	1
193	LOAD CONTROL INDICATOR SCALE AND POINTER ASSEMBLY	1
194	OVERRIDING CYLINDER	1
195	TAPER SCREW, 1/4-28	2
196	OVERRIDING CYLINDER HEAD	1
197	L.C. PLUNGER OIL SEAL	1
198	SPACER (IF NO OIL SEAL)	1
199	L.C. OIL SEAL GASKET	1
200	L.C. PILOT VALVE PLUNGER	1
201	L.C. PILOT VALVE BUSHING SPRING	1
202	L.C. PILOT VALVE BUSHING	1
203	BUSHING SNAP RING, WALDES 50-43	1
	OIL FAILURE – WATER FAILURE SHUTDOWN MECHANISM	
204	SOC. HD. CAPSCREW, 1/4-28 X 3/4	2
205	SPLIT LOCKWASHER, 17/64	2
206	ADAPTOR CAP	1
207	SEALING DIAPHRAGM NUT, SPECIAL, 3/8-24	2
208	SEALING DIAPHRAGM WASHER	1
209	SEALING DIAPHRAGM	1
210	DIAPHRAGM STOP SCREW	1
211	SEALING DIAPHRAGM HOLDER	
212	SEALING DIAPHRAGM SPRING	1
213	VALVE SEAT NUT, SPECIAL, 3/8-24	1
214	BALL VALVE SEAT	1
215	STEEL BALL, 3/16 DIAM.	1
216	VALVE BODY O-RINGS, AN6230-2	3
217	VALVE BODY	1
	(ALL UNITS WITH LUBE OIL PRESSURE FAILURE PROTECTION)	
218	OIL PRESSURE FAILURE DIAPHRAGM SPRING	1
219	ELASTIC STOP NUT, THIN, 10-32	1
220	OIL FAILURE DIAPHRAGM WASHER	1
221	OIL PRESSURE FAILURE DIAPHRAGM	1
222	OIL FAILURE VALVE PLUNGER	1
223	STRAIGHT HALF UNION, 1/2 NPT, 1/4 TUBE	AR
229	SIDE PLATE SCREWS AND LOCKWASHERS	NI
230	LOAD CONTROL SIDE PLATE (SQAURE DIAPHRAGM COVER)	1
231	SIDE PLATE GASKET	NI
232	SOC. HD. CAPSCREW, 1/4-28 X 3/8	1
233	WASHER, 1/4	1
234	OIL FAILURE VALVE BUSHING ASSEMBLY	1
235	OIL FAILURE VALVE BUSHING GASKET	1
236	OIL PRESSURE FAILURE PISTON	1
237	OIL FAILURE PISTON SPRING	1
241	NAMEPLATE SCREWS, 8-32 X 1/4	4
242	NAMEPLATE (LARGE) ON COLUME	1
	AUTOMATIC AND MANUAL SHUTDOWN PLUNGER PARTS	
243	PLUNGER TUBING – RED	1
244	O-RING, AN6227-7	1
245	SHUTDOWN PLUNGER	1
246	BALL VALVE SPRING	1
247	HEADED PIN	1
248	STEEL BALL, 1/4	1
249	SHUTDOWN PLUNGER PIN	1
250	BALL VALVE SEAT	1
251	SHUTDOWN PLUNGER SPRING	1
	STRIPPED COLUMN	
252	COLUMN AND INSERT ASSEMBLY	1
253	HEX. HD. CAPSCREW, 5/16 X 4-23/32	4
254	SPLIT LOCKWASHER, 5/16	4
255	O-RING, AN6227-5 (TRANSFER HOLES, OIL AND AIR, TOP OF COLUMN NI	AR
256	NEOPRENE RING (TRANSFER HOLE FOR SPEED SETTING OIL, CASE TO COLUMN NI	1
257	PIPE PLUG, HEX. SOC., 1/16 NPT	AR
258	PIPE PLUG, HEX. SOC., 1/8 NPT	AR
259	PIPE PLUG, HEX. SOC., 1/4 NPT NI	AR
260	PIPE PLUG, HEX. SOC., 3/8 NPT NI	AR
261	DECAL PIPE CONNECTION LABELS NI	AR
262	DECAL OIL LEVEL LABEL	1
263	NAMEPLATE INSERT NI	1
264	NAMEPLATE INSERT SCREWS, 5-40 X 1/4 NI	2
265	NAMEPLATE (SMALL) ON COLUMN (IF USED) NI	1
266	DRIVE SCREW NI	2
579	HEX. HD. CAPSCREW, 1/4-28 X 2-3/4	2
580	SPLIT LOCKWASHER, 17/64	2
581	COVER	1
582	PIN	1
583	ROD	2
584	SPRING	2
585	O-RING	2
586	TUBE	1
587	HEX. NUT, 3/8-24	2
588	WASHER	2
589	DIAPHRAGM, SPEED SETTING PISTON OIL	1
590	BODY	1
591	DIAPHRAGM HOLDER	1
592	DIAPHRAGM, WATER PRESSURE FAILURE	1
593	SPRING	1
594	BASE	1
595	DISK	1
596	SPLIT LOCKWASHER, 17/64	2
597	SOC. HD. CAPSCREW, 1/4-28 X 1-3/8	2
598	CAP	1
599	PLUG, 1/8 IN. PIPE	1

NOTE: AR – AS REQUIRED, NI – NOT ILLUSTRATED.

ALL DIMENSIONS IN INCHES.

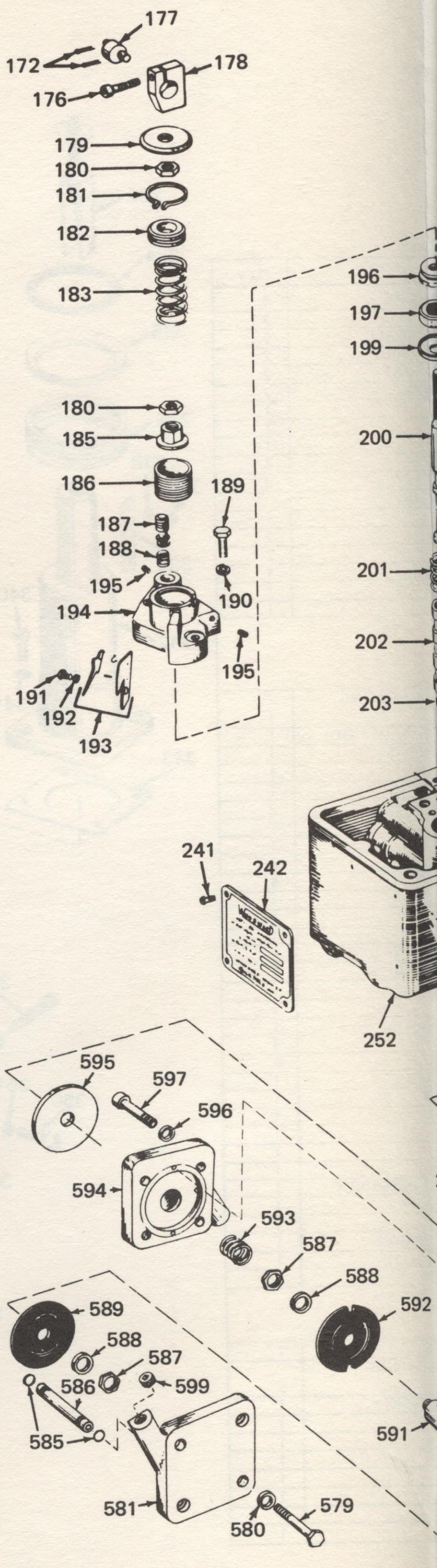

FIG. 40. LOAD CONTROL V

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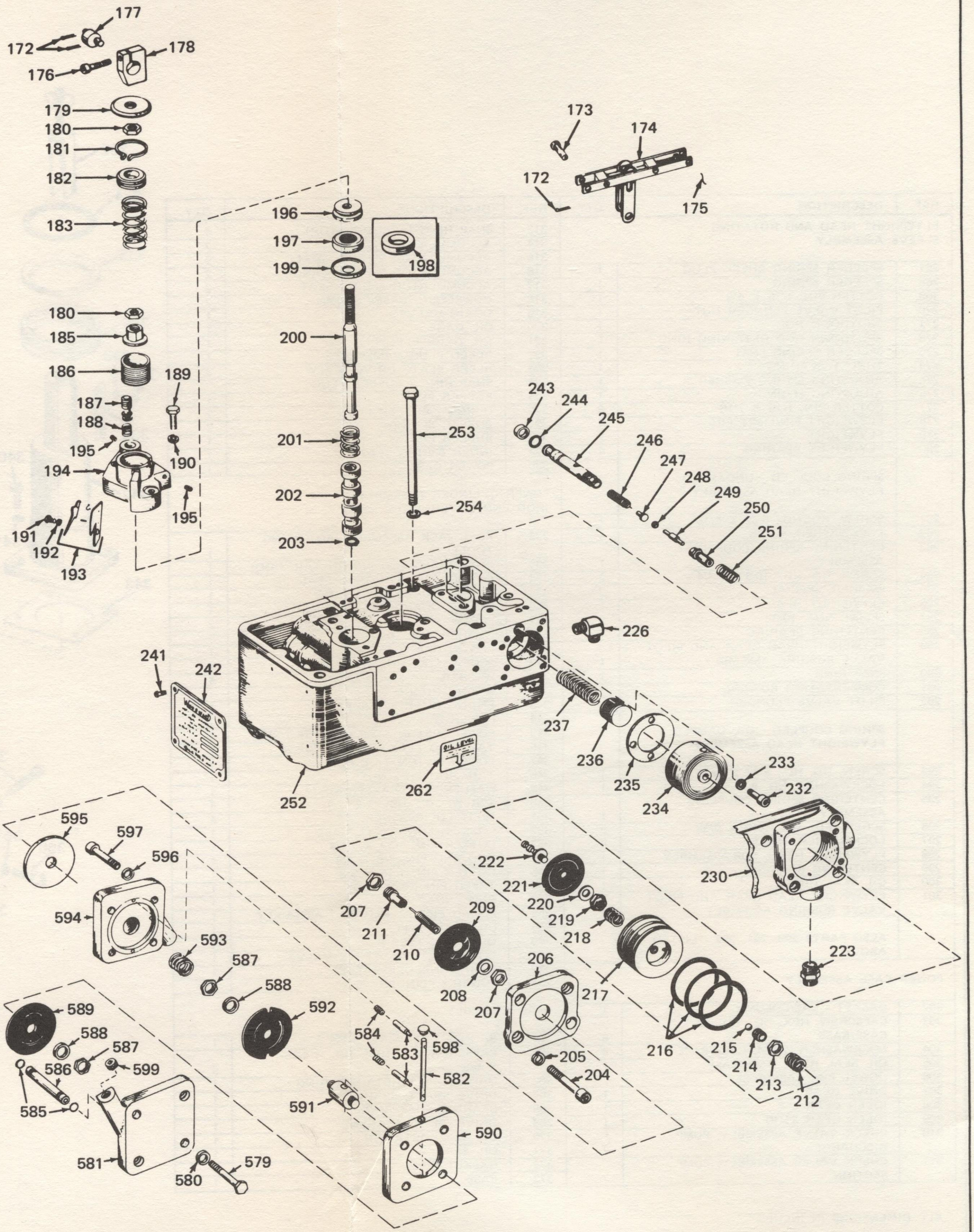
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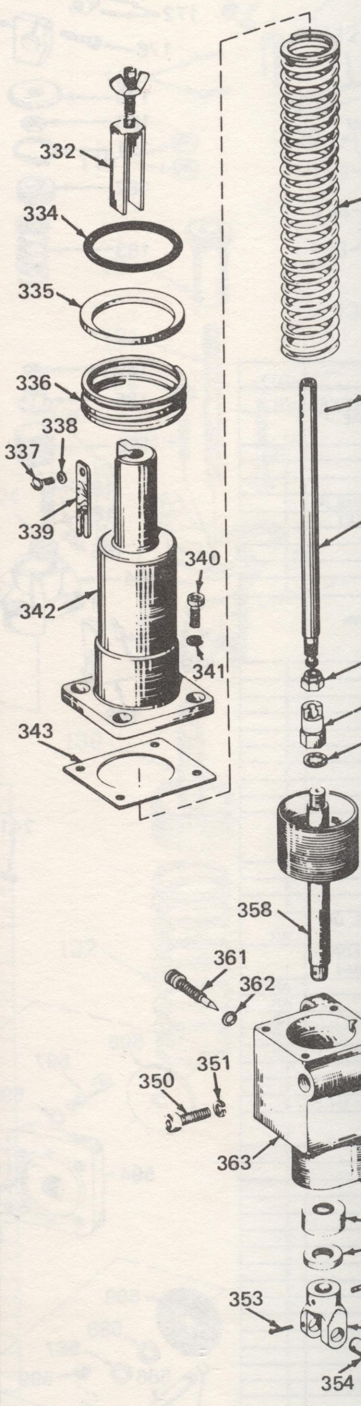
FIG. 40. LOAD CONTROL VALVE, OVERRIDING VALVE, OIL FAILURE SHUTDOWN MECHANISMS.

REF.	DESCRIPTION	QTY.
	FLYWEIGHT HEAD AND ROTATING SLEEVE ASSEMBLY	
267	SPEEDER SPRING CHECK PLUG	1
268	SPEEDER SPRING	1
269	COTTER PIN, 1/16 X 5/8	1
270	PILOT VALVE PLUNGER NUT	1
271	SHUTDOWN ROD	1
272	SHUTDOWN ROD RETAINING RING	1
273	SPEEDER SPRING SEAT	1
274	THRUST BEARING	1
275	ADJUSTING SPRING WASHER	1
276	ADJUSTING SPRING	1
277	COTTER PIN, 1/16 X 7/16	8
278	FLYWEIGHT PIN/LIMIT PIN	4
279	FLYWEIGHT	2
280	FLYWEIGHT BEARING	4
	SPRING COUPLED - UNDAMPED FLYWEIGHT HEAD ASSEMBLY	
281	SCREW, RD. HD., 6-32 X 5/16	1
282	LOCKWASHER, NO. 6	1
283	CENTERING SPRING COUPLING ASSEMBLY	1
284	SCREW, RD. HD., 10-32 X 3/4	2
285	WASHER, SPECIAL	2
286	FLYWEIGHT HEAD	1
287	SPLINE NUT, 10-32	2
288	CENTERING BEARING	1
289	FLYWEIGHT HEAD GEAR AND PILOT VALVE BUSHING ASSEMBLY	1
290	SNAP RING	1
291	COMPENSATING BUSHING	1
292	PILOT VALVE PLUNGER	1
	SPRING COUPLED - OIL DAMPED FLYWEIGHT HEAD ASSEMBLY	
293	SCREW, RD. HD., 8-32 X 5/16	1
294	LOCKWASHER, NO. 8	1
295	CENTERING SPRING COUPLING ASSEMBLY	1
296	SCREW, FIL. HD., 5-40 X 9/32	8
297	LOCKWASHER, NO. 5	8
298	FLYWEIGHT HEAD, SUB-ASSEMBLY	1
299	CENTERING BEARING	1
300	OIL SEAL RING	1
301	FLYWEIGHT HEAD GEAR AND PILOT VALVE BUSHING ASSEMBLY	1
	ALSO PARTS 290, 291, 292 - LISTED ABOVE.	
	POWER CASE ASSEMBLY	
302	GASKET - CAS/COLUMN	1
303	CAPSCREW, HEX. HD., 5/16-18 X 1, CASE/BASE	8
304	LOCKWASHER, 21/64, CASE/BASE	8
305	OIL SEAL RING, CASE/BASE	1
306	DOWEL PIN, CASE/BASE	2
307	DRIVE GEAR	1
308	IDLER GEAR	1
309	IDLER GEAR STUD	1
310	CHECK VALVE ASSEMBLY, PUMP DISCHARGE	2
311	CHECK VALVE ASSEMBLY, PUMP SECTION	2

REF.	DESCRIPTION	QTY.
313	SNAP RING (ACCUMULATOR)	4
314	ACCUMULATOR PISTON	2
315	ACCUMULATOR SPRING, SMALL	2
316	ACCUMULATOR SPRING, LARGE	2
317	ACCUMULATOR SPRING SEAT	2
318	DOWEL PIN, CASE/COLUMN	2
319	DRAIN VALVE	1
320	OIL GAGE	1
321	OIL GAGE ELBOW	1
322	BLEED PLUG NAMEPLATE	1
323	BLEED PLATE DRIVE SCREW	3
324	SNAP RING - BUFFER PLUG	
325	BUFFER PLUG	1
326	O-RING - BUFFER PLUG	1
327	BUFFER SPRING	2
328	BUFFER PISTON	1
329	INNER SPRING SEAT	1
330	POWER CASE	1
	POWER CYLINDER ASSEMBLY (ROD END GOVERNOR)	
332	FUEL JACK ASSEMBLY (ADJUSTING TOOL)	1
333	FUEL INDICATOR PIN (IN TAIL ROD)	1
334	O-RING, SPRING UGARD SEAL	1
335	SPRING GUARD SEAL RING	1
336	SPRING GUARD SEAL SPRING	1
337	SCREW, PHIL. HD., 10-32 X 3/8	2
338	WASHER, NO. 10	2
339	PISTON GAP SCALE	1
340	SCREW, SOC. HD., 1/4-28 X 1/2	4
341	WASHER, 1/4 SHAKEPROOF	4
342	SPRING GUARD	1
343	SPRING GUARD GASKET	1
344	POWER SPRING	1
345	POWER PISTON STOP RING (IF USED)	1
346	TAIL ROD FLEX-LOC NUT, 3/8-24	1
347	POWER PISTON TAIL ROD	1
348	TAIL ROD LIFT NUT	1
349	WASHER, 3/8 SHAKEPROOF	1
350	SCREW, SOC. HD., 3/8 X 1	4
351	SPLIT LOCKWASHER, 3/8	4
352	GASKET, POWER CYL./CASE	1
353	COTTER PIN, 3/32 X 1-1/4	1
354	ROD END PIN, 3/8 X 7/8	1
355	COTTER PIN, 1/16 X 3/8	1
356	TAPER PIN (ROD END)	1
357	ROD END	1
358	POWER PISTON AND ROD ASSEMBLY	1
359	OIL SEAL, TYPE G	1
360	OIL SEAL' TYPE P	1
361	COMPENSATING NEEDLE VALVE	1
362	O-RING (NEEDLE VALVE)	1
363	POWER CYLINDER	1
	BASE ASSEMBLY	
364	BRONZE LOCKWIRE, 0.035 X 6	1
365	CAPSCREW, DR. HEX. HD., 1/4-28 X 5/8	3
366	DRIVE SHAFT RETAINER RING	1
367	DRIVE SHAFT, SERRATED	1
368	BEARING SNAP RING	1
369	DRIVE SHAFT BEARING	1
370	OIL SEAL RETAINER	1
371	OIL SEAL	1
372	GASKET RING	1
373	BASE	1



ALL DIMENSIONS IN INCHES.

FIG. 41. FLYWEIGHT HEADS, ROTATING SLEEVE, POWER CASE, POWER CYLINDER, AND BASE.

	QTY.
TOR)	4
	2
, SMALL	2
, LARGE	2
SEAT	2
UMN	2
	1
	1
	1
TE	1
CREW	3
PLUG	
	1
G	1
	2
	1
	1
	1

(ADJUSTING	1
(IN TAIL ROD)	1
D SEAL	1
RING	1
SPRING	1
32 X 3/8	2
	2
	1
28 X 1/2	4
ROOF	4
	1
ET	1
	1
RING (IF USED)	1
NUT, 3/8-24	1
ROD	1
.	1
ROOF	1
X 1	4
3/8	4
/CASE	1
-1/4	1
7/8	1
3/8	1
)	1
	1
ROD ASSEMBLY	1
	1
	1
LE VALVE	1
LVE)	1
	1

0.035 X 6	1
HD., 1/4-28	3
NER RING	1
ATED	1
G	1
ING	1
	1
	1
	1
	1

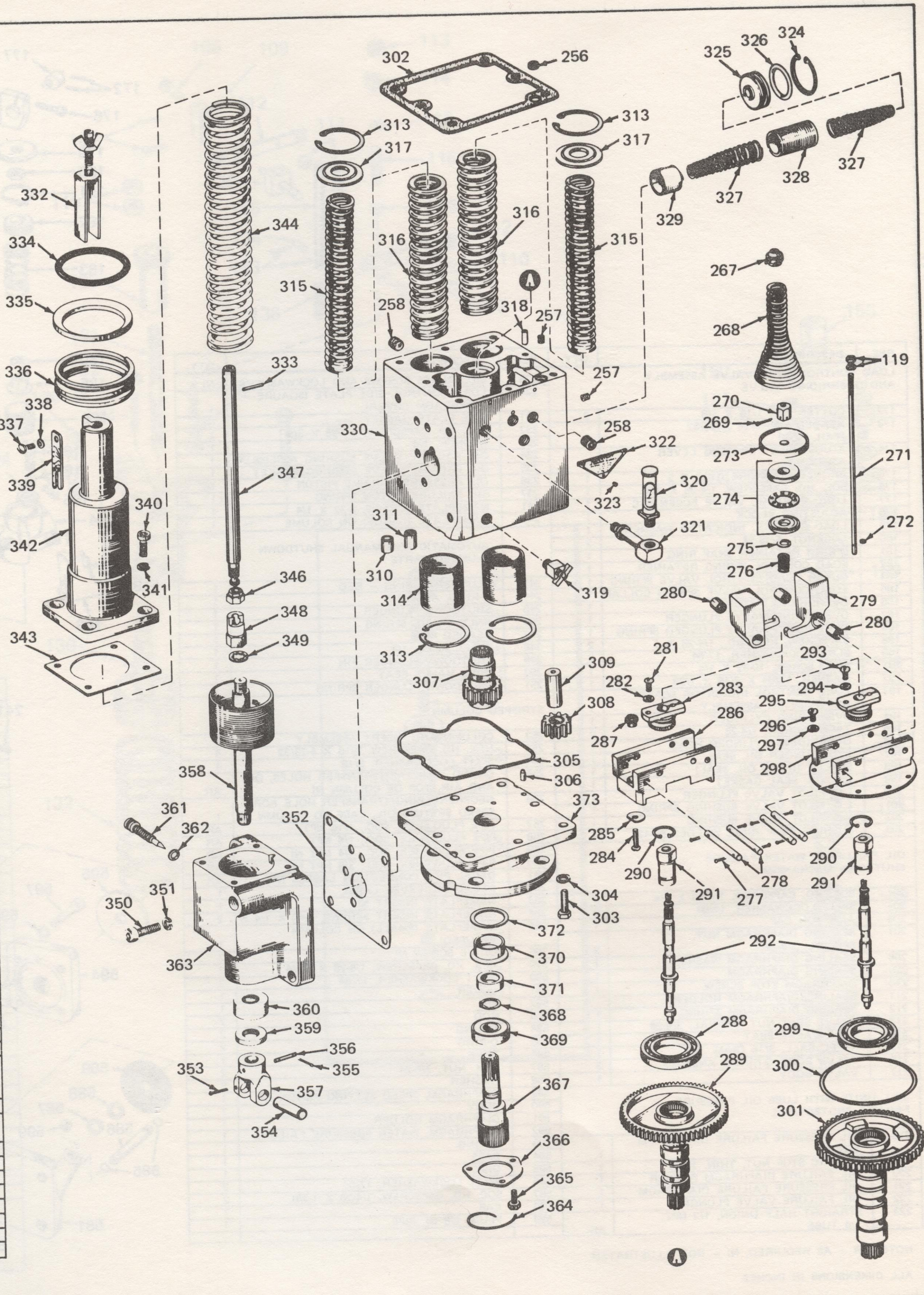

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FIG. 41, E-9546

WER CYLINDER, AND BASE.

FIG. 42, E-11767

REF.	DESCRIPTION	QTY.
ROTARY VANE SERVO ASSEMBLY		
501	HEX. NUT, 1/4-28	2
502	WASHER, 1/4 SHAKEPROOF	2
503	CAP SCREW, SOC. HD., 1/4-28 X 1	2
504	WASHER, SPLIT LOCK, 1/4 X 1/16	4
505	SERVO END PLATE	1
506	DOWEL, 0.250 X 1	4
507	END PLATE PLUG	1
508	SOC. PIPE PLUG, 1/8 NPT	1
509	NEEDLE BEARING	2
510	SERVO HOUSING AND DIVIDER ASSEMBLY	1
511	OIL SEAL RING	2
512	VANE INSERT	2
513	INSERT LOAD SPRING	2
514	ROTARY SERVO SHAFT ASSEMBLY	1
515	CAP SCREW, SOC. HD., 1/4-28 X 3/4	2
516	SERVO BACK PLATE	1
517	O-RING, BACK PLATE SEAL	1
518	O-RING, SERVO OIL CONNECTIONS	2
519	SERVO BACK PLATE (OLD STYLE)	1
520	BACK PLATE GASKET (OLD STYLE)	1
521	MOUNTING STUD (IN SIDE PLATE)	2
SIDE PLATE COVER ASSEMBLY		
522	CAP SCREW, SOC. HD., 1/4-20 X 2-1/8	8
523	CAP SCREW, SOC. HD., 1/4-28 X 3	4
524	WASHER, 1/4 SPLIT LOCK	12
525	SCREW, PHIL. FLAT HD., 6-32 X 3/8	6
526	RHEOSTAT DIAL PLATE	1
527	DIAL GLASS GASKET	2
528	DIAL GLASS	1
529	DRAIN VALVE	1
530	SIDE PLATE COVER	1
531	SIDE PLATE COVER GASKET	1
LOAD CONTROL RHEOSTAT ASSEMBLY		
532	INDICATOR LOCK NUT	1
533	LOCKWASHER	1
534	INDICATOR BUTTON	1
535	INDICATOR ASSEMBLY	1
536	BRUSH DRIVE SHAFT SNAP RING	1
537	BRUSH DRIVE SHAFT	1
538	DRIVE SHAFT LOCATOR PIN	1
539	"SEMS" SCREW, 5-40 X 1/4 (TERMINALS) NI	3
540	"SEMS" SCREW, 6-32 X 1/2 (FOR 541) NI	2
541	TERMINAL BLOCK (3 WIRE)	1

REF.	DESCRIPTION	QTY.
542	FIBRE INSULATING WASHER (FOR 541)	2
543	"SEMS" SCREW, 6-32 X 1/2 (FOR 544) NI	4
544	TERMINAL BLOCK (4 WIRE)	1
545	CAP SCREW, SOC. HD., 8-32 X 3/8	2
546	INSULATING WASHER	4
547	ELASTIC STOP NUT, 8-32	4
548	RESISTOR LEAD WIRE RETAINER	1
549	SCREW, DR. SOC. HD., 8-32 X 3/4	4
550	SPACER BUSHING	4
551	SCREW, SOC. HD., 8-32 X 1-1/8	2
552	LOCKWASHER, NO. 8	2
553	SCREW, PHIL. FLAT HD., 8-32 X 7/8	2
554	COMMUTATOR PLATE	1
555	SPACER DISK	1
556	COMMUTATOR AND RESISTOR PACK ASSEMBLY	1
557	SOC. HD. CAP SCREW, 10-32 X 3/4	4
558	SPLIT LOCKWASHER, NO. 10	4
559	DIAPHRAGM CAP, ROUND	1
560	DIAPHRAGM CAP, GASKET	1
561	CAP SCREW, SOC. HD., 1/4-28 X 3/4	10
562	WASHER, 1/4 SPLIT LOCK	10
563	SIDE PLATE	1
564	SIDE PLATE GASKET	1
	ADDITIONAL PARTS USED WITH INTEGRAL LOAD REGULATOR:	
565	LOAD-CONTROL OIL-SUPPLY VALVE PLUNGER	1
566	LOAD-CONTROL OIL-SUPPLY VALVE SPRING	1
567	LOAD-CONTROL OIL-SUPPLY VALVE SLEEVE	1
	BALL CHECK VALVES - IN COLUMN - FOR INTEGRAL LOAD REGULATOR TIMING:	
568	SOC. HD. SCREW, 1/4-28 X 3/8	1
569	INSTRUCTION PLATE	1
570	RETAINER BLOCK	1
571	ADJUSTING NEEDLE	2
572	O-RING (ADJUSTING NEEDLE)	4
573	SNAP RING, WALDES 50-31	2
574	BALL VALVE SPRING PLUG	2
575	BALL VALVE SPRING	2
576	STEEL BALL, 3/16	2
577	BALL-CHECK-VALVE BODY	2
578	BALL-CHECK-VALVE HOLE PLUG	2
	NOTE: NI - NOT ILLUSTRATED.	

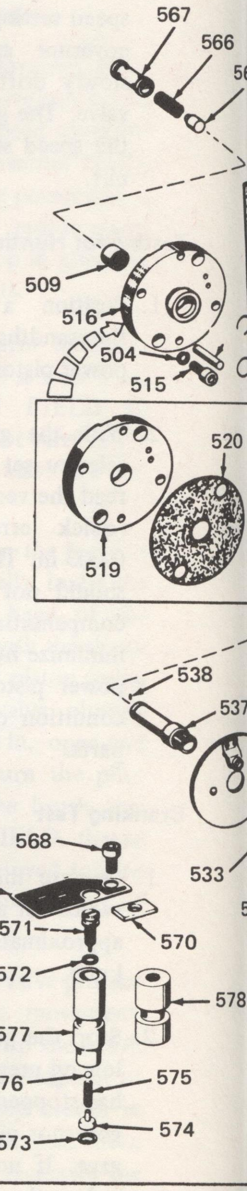

FIG. 42. INTEGRAL LOAD REGULATOR,

	QTY.
G WASHER (FOR 541)	2
-32 X 1/2 (FOR 544) NI	4
(4 WIRE)	1
HD., 8-32 X 3/8	2
HER	4
JT, 8-32	4
WIRE RETAINER	1
HD., 8-32 X 3/4	4
	4
8-32 X 1-1/8	2
). 8	2
AT HD., 8-32 X 7/8	2
ATE	1
	1
ID RESISTOR PACK	1
REW, 10-32 X 3/4	4
ER, NO. 10	4
ROUND	1
GASKET	1
HD., 1/4-28 X 3/4	10
T LOCK	10
	1
KET	1
TS USED WITH INTEGRAL R:	
OIL-SUPPLY VALVE	1
OIL-SUPPLY VALVE	1
OIL-SUPPLY VALVE	1
LVES - IN COLUMN - FOR REGULATOR TIMING:	
1/4-28 X 3/8	1
ATE	1
	1
LE	2
NG NEEDLE)	4
DES 50-31	2
ING PLUG	2
ING	2
S	2
VE BODY	2
VE HOLE PLUG	2
ILLUSTRATED.	

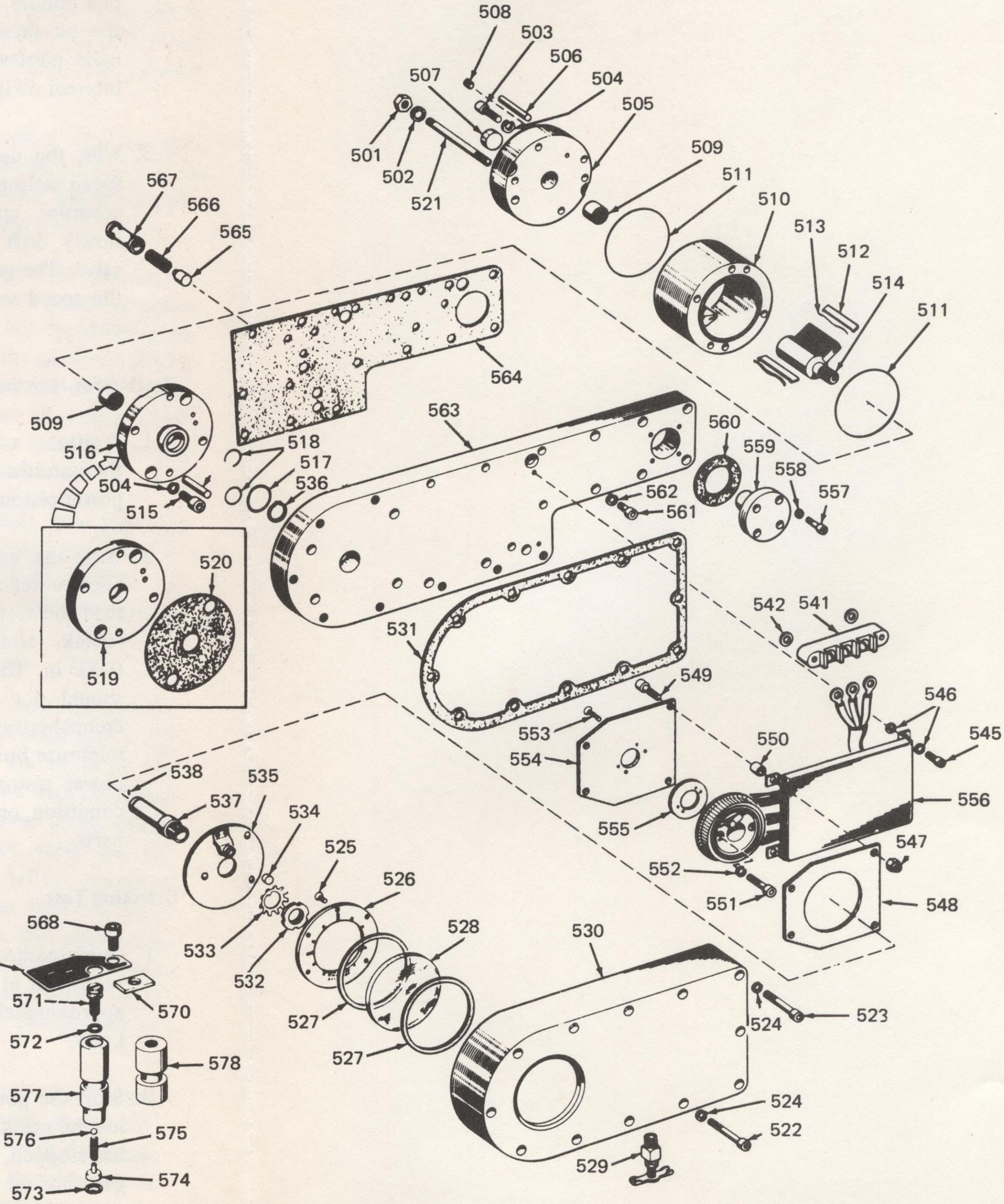
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FIG. 42. INTEGRAL LOAD REGULATOR, LOAD CONTROL OIL SUPPLY VALVE, AND ADJUSTABLE BALL VALVES.

Compensating Needle Valve Test

1. Install the manual speed setting nut on the stud bolt provided. Adjust the nut to set idle speed on the governor. Adjust the governor to be operating near the mid point of its power piston travel, by turning the air motor speed adjusting knob.

2. Turn the compensating needle valve tightly closed. Observe the tachometer reading for approximately one minute. If the speed drifts off, this indicates that the oil pressure seals around the power piston and main pilot valve are not functioning properly or the internal oil leakage past these parts is excessive.

3. With the needle valve still closed, turn the manual speed setting nut down to a higher speed setting. The governor speed should increase somewhat, then slowly drift higher. Open the compensating needle valve. The governor speed should increase quickly to the speed setting. Remove the manual speed setting nut.

Testing for Hunting and Jiggling

1. Position a dial indicator, calibrating to read thousandths of inches, to contact the top end of the power piston tail rod.

2. With the governor operating at idle speed (speed selector set at IDLE) and controlling the test stand, read the vertical movement of the tail rod. The jiggle (quick erratic movements) should not exceed 0.003 in. The hunting (slower rhythmic movements) should not exceed 0.005 in. During this test, the compensating needle valve should be adjusted to minimize hunting. Excessive hunting or jiggling at the power piston tail rod may be caused by a binding condition on one or more of the moving governor parts.

Cranking Test

1. Operate the governor at idle speed (speed selector switch set at IDLE). Position the power piston gap to approximately 1/2 in. by adjusting the speed control knob.

2. Stop the governor and test stand by pulling out the low oil pressure shutdown plunger. After the governor has stopped, reset the plunger. Check to see that the governor oil pressure is zero as indicated on the panel gage. If not, lift upward on the shutdown rod to reduce the pressure to zero.

3. Start and operate the governor at 60 to 70 rpm by slowly pulling outward on the cable attached to the air motor throttle valve. Sufficient accumulator pressure must be developed by the governor pump to raise the power piston from shutdown to the idle piston gap of 1/2 in. If this does not occur, trouble within the oil pump system is indicated. The governor oil pump pressure should be at least 90 psi at 300 rpm and 100 psi at 500 rpm.

SPEED SETTINGS

When adjusting the governor speed settings on the test stand, maintain the governor piston gap at approximately 1/2 in. to assure that the governor is controlling the test stand speed. Be sure the manual speed setting nut has been removed. Adjust the speeds to agree with those given on the governor data sheet.

1. Move the test stand speed selector switch to position No. 6. Solenoids A, B, C and D should become energized and the governor speed should increase. Set the 6th notch speed by adjusting the base speed setting nut. Turn the nut counterclockwise to raise the speed setting.

2. Move the speed selector switch to Position 8. Adjust the 8th notch speed by turning the stop screw in the top of solenoid D. (Turn the screw counterclockwise to raise the speed.)

3. Move the speed selector switch to Position 7. Adjust the 7th notch speed by turning the stop screw at the top of solenoid A. (Turn the screw clockwise to raise speed.)

4. Move the speed selector switch to Position 4. Adjust the 4th notch speed by turning the stop screw in the top of solenoid B. (Turn the screw clockwise to raise speed.)

5. Move the speed selector switch to IDLE. Adjust the idle speed by turning the stop screw in the top of solenoid C. (Turn the screw clockwise to raise speed.)

6. Check all speed settings in an ascending direction beginning at IDLE to assure that they are within the limits specified. If necessary, all settings may be raised or lowered an equal amount by readjusting the base speed setting nut.

7. Check all speed settings in a descending direction beginning at the 8th notch. Readings for each notch should be within 2 rpm of those taken in Step 6 above. If the speed setting differs more than 2 rpm, check for bound parts in the governor speed regulating system.

8. Adjust the shutdown nuts, speed setting piston stop screw and, if used, the start fuel limiting device. See instruction given under GENERAL MAINTENANCE AND ADJUSTMENTS TO GOVERNOR ON THE ENGINE section.

   These adjustments should be made with the speed selector switch in IDLE position. After the adjustments are complete, position the speed selector switch to OFF. The governor power piston should move to its SHUTDOWN position (maximum power piston gap) and, if the air motor speed adjusting knob is correctly set, the governor and test stand will shut down.

9. Check the time required for the governor to accelerate from IDLE to 8th notch speed by quickly moving the speed selector switch from IDLE to Position 8. Make sure the speed adjusting knob is set to permit full travel of the governor power piston. See the governor DATA sheet for specified time.

10. Check the action of the governor compensation system. While observing the tachometer, increase then decrease the governor speed setting notch by notch. Note that the governor speed reaches an ON SPEED condition without or with only a slight over shoot and under shoot respectively. The compensating needle valve may require slight readjustment to improve this condition.

    Check to see that when the governor speed is lowered in increments of two or more notches, the governor power piston moves toward its FULL OFF position (maximum power piston gap), then moves quickly to some lesser gap to maintain the governor ON SPEED at the lower speed setting. When conducting this test, adjust the governor power piston gap to approximately 1/2 in.

11. Check the calibration of the governor speed indicator scale with the governor operating at IDLE and FULL SPEED. If, with the governor operating at its correct speed, the indicator pointer does not coincide with the scale markings (idle mark and full speed scribed line), adjust the position of the scale plate to be correct at IDLE speed. Then operate the governor at FULL SPEED and scribe a new line, indicating it to be the correct one.

LOAD CONTROL PILOT VALVE ADJUSTMENT

1. Be sure the overriding solenoid is de-energized (switch on test stand positioned to OFF). Loosen the locknut on the top of the "O" solenoid and turn the adjusting screw to position the plunger at least 2-1/2 turns off the bottom. This is necessary to assure that the overriding solenoid does not affect the operation of the load control pilot valve while making the following adjustments.

2. Turn the adjustment screw in the floating lever, over the load control pilot valve, to obtain a 5/8 in. gap between the back side of the pilot valve pivot block and the front side of the rear spacer block in the floating lever. See dimension X in Fig. 21. This is only an approximate setting which may require readjustment later.

3. Loosen the clamp screw on the pilot valve eccentric adjustment and position the eccentric so that its lobe faces the speed setting cylinder and the screwdriver slot is horizontal. Tighten the clamp screw.

4. Operate the governor and adjust the governor speed to be correct at IDLE speed. Set the governor power piston gap to that specified for idle speed using the power piston gap gage. Refer to the governor DATA sheet for the correct settings. Clamp the power piston gap gage firmly by adjusting the air motor speed adjusting knob. Disregard the slight drop in governor speed as it will not affect the adjustments.

5. Observe the position of the brush arm indicator (white dot in window). If the indicator is now at or moving towards either MAXIMUM FIELD or MINIMUM FIELD, the load control pilot valve is not centered, (control lands on the pilot valve are not fully covering the ports in the bushing).

   If the pilot valve is not centered, loosen the locknut on the pilot valve stem under the umbrella. Insert the bit of a long screwdriver under the head of the eccentric adjustment clamp screw and with the shank of the screwdriver resting on the power piston spring guard, pry up to raise the pilot valve plunger approximately 1/2 in. Use a thin 1/2 in. open-end wrench to loosen the locknut, then turn the pilot valve plunger. If in the above test, the brush arm indicator moved toward MAXIMUM FIELD, thread the valve plunger into the block. If it moved toward MINIMUM FIELD, thread the valve plunger out of the block.

   After each adjustment, release the pilot valve plunger and observe the brush arm indicator movement. Continue to adjust the valve plunger until the brush arm indicator, when positioned near its midpoint of travel, remains stationary or just barely creeps in either direction. When this condition has been reached, tighten the locknut and recheck the adjustment.

6. With the brush arm indicator stationary near its mid-point, set the pilot valve indicator pointer to exactly coincide with the "O" mark on the indicator scale. To do this, loosen the indicator mounting screw and shift the indicator scale up or down, then tighten the screw.

7. After the pilot valve indicator has been calibrated, loosen the eccentric clamp screw and turn the eccentric to position the pilot valve indicator pointer to exactly coincide with either the MAXIMUM or MINIMUM FIELD start marks on the indicator scale. Refer to the governor DATA sheet for the specified setting.

8. Operate the governor at 8th notch speed. Set the governor power piston gap to that specified for full speed and full load using the power piston gap gage. Refer to the governor DATA sheet for correct settings. Turn the air motor speed adjusting knob to cause the gage to be tightly clamped. Disregard the slight drop in governor speed as it will not affect the adjustments.

   The load control pilot valve indicator pointer should now coincide with the "O" mark on the scale and the brush arm indicator should remain stationary or barely creep when positioned near its mid-point of travel.

9. If in Step 8 the brush arm indicator has moved or is moving toward the MINIMUM FIELD position, the pilot valve plunger is above center. (The indicator pointer should confirm this.) Lower the valve plunger by turning the screw in the floating lever to increase dimension X which was previously set at 5/8 in. Move the block only enough to bring the pointer half way toward the zero mark on the indicator scale. Adjust the eccentric over the valve plunger to bring the pointer the remaining distance and exactly in-line with the zero mark, and thus center the pilot valve.

10. If in Step 8 the brush arm indicator has moved or is moving toward the MAXIMUM FIELD position, the pilot valve plunger is below center. (The indicator pointer should confirm this.) Raise the valve plunger by turning the screw in the floating lever to decrease dimension X which was previously set at 5/8 in. Move the block only enough to bring the pointer half way toward the zero mark on the indicator scale. Adjust the eccentric over the valve plunger to bring the pointer the remaining distance and exactly in-line with zero mark, and thus center the pilot valve.

11. Return the governor to the idle speed setting as used in Step 4. The brush arm indicator should move to the specified position (MAXIMUM or MINIMUM FIELD) and the indicator pointer should coincide with the corresponding mark on the indicator scale. If the settings are incorrect, repeat the above steps beginning at Step 4.

12. Readjust the overriding solenoid. See Adjusting Overriding Solenoid section.

VANE SERVOMOTOR TIMING ADJUSTMENTS

On governors equipped with adjustable vane servomotor timing, refer to the governor DATA sheet, the instruction plate in the governor, and instruction covering adjustments for settings.

OVERRIDING SOLENOID ADJUSTMENTS

Refer to the instructions given under GENERAL MAINTENANCE AND ADJUSTMENTS TO THE GOVERNOR ON THE ENGINE section.

SAFETY SHUTDOWN ADJUSTMENTS

Bypass Valve Adjustment

The socket head set screw located in the triangular plate over the bypass valve must be adjusted so that when the pressure is removed from the engine oil pressure diaphragm, the governor shuts down after a time delay at IDLE and 1st notch speed while at 2nd notch or above, shutdown is immediate. This screw can be adjusted by inserting the straight No. 10 Allen wrench supplied in the governor tool kit through the hole between solenoids C and D.

Back-off the screw two turns CCW. Then operate the governor at 2nd notch speed. Close the lube oil supply valve and open the lube oil bleed valve reducing the diaphragm pressure to zero. While the shutdown mechanism is timing out, quickly turn the adjustment screw in (CW) until the point is reached at which immediate governor shutdown occurs. When this point is reached, turn the screw 1/4 turn more and remove the wrench. Recheck the adjustment noting that the time delay on shutdown is only present at IDLE and 1st notch speed.

SHUTDOWN TIME DELAY ADJUSTMENT

With the governor operating at IDLE, check the elapsed time between the time the bleed valve is fully opened, dropping the diaphragm pressure to zero, and the time at which the shutdown plunger trips shutting down the governor. Refer to the governor DATA sheet for specified time.

The time delay may be adjusted by moving the regulating bushing retainer. Moving the pointer clockwise will reduce the trip time delay.

OIL PRESSURE-WATER PRESSURE SHUTDOWN ADJUSTMENT AND TESTS

With the governor shut down, remove the two hex head capscrews and remove the water shutdown portion of the device including the external oil supply tube. Install a plug in the threaded tube opening in the load control backplate to seal off the speed setting piston oil. Place a container under the drain port of the shutdown device to catch drainage oil. Back off the adjustment screw two full turns, then start the governor operating at idle speed, with the diaphragm oil pressure adjusted to 35 to 50 psi. Slowly turn the adjusting screw in until it just contacts the ball. This point can be found by turning the adjustment screw in until oil just begins to flow from the drain port, then, back off the screw until the leakage just stops. When this point is found, back out the screw one full turn. Leave it at this setting.

Shut down the governor and replace the water shutdown portion of device.

CHECKING OIL DIAPHRAGM SHUTDOWN PRESSURE

Operate the governor at IDLE speed with 25 psi air pressure applied to the water pressure failure diaphragm and 35 to 50 psi oil pressure on the oil pressure failure diaphragm. Close the lube oil pressure supply valve and slightly open the pressure bleed valve to cause a gradual decrease in diaphragm oil pressure. Note and record the pressure at which the shutdown plunger begins to move out. Operate the governor at full speed and once again slowly reduce the diaphragm pressure using the oil pressure bleed valve. Note and record the pressure at which the shutdown plunger snaps out, shutting down the governor. Refer to the governor DATA sheet for specified shutdown pressures.

The oil pressures at which the safety shutdown mechanism functions are determined mainly by the speed setting piston spring. Therefore, if the shutdown pressures are incorrect, the speed setting piston spring must be renewed.

CHECKING WATER DIAPHRAGM SHUTDOWN PRESSURES

Operate the governor at 2nd notch speed with 25 psi air pressure applied to the water pressure failure diaphragm and 35 to 50 psi oil pressure applied to the oil pressure failure diaphragm. Slowly reduce the air pressure by adjusting the pneumatic transmitter control valve on the test stand. Note and record pressure at which the device trips, shutting down the governor.

Operate the governor at full speed and once again slowly decrease the air pressure on the water pressure failure diaphragm, recording the pressure at which the device trips shutting down the governor. Refer to the governor DATA sheet for specified shutdown pressures.

After completing the governor testing and adjustments, open the OIL OUT valve, allowing the oil in the governor to drain to the tank in the test stand. Restore the governor cover and disconnect and remove the governor from the stand.

PREPARING THE GOVERNOR FOR STORAGE

If the governor is to be stored for a period of time, it must be properly protected against rusting of the parts and the entrance of dust and dirt into the mechanism. Remove the oil sight gage from the governor and install a pipe plug in the hole. Wrap the gage in protective paper and attach it to the governor using wire. Fill the governor to the top of the power case with a good rust preventative oil. Also coat the levers and other parts in the top of the column before applying the cover. Coat the exposed portion of the power piston rod with oil and wrap with protective paper. Seal off the electrical connector with masking tape. Then store the governor in a clean, dry area.